MLADEN JOVANOVIĆ

STRENGTH TRAINING MANUAL

The Agile Periodization Approach

Volume II

Strength Training Manual

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Volume Two

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Published by:

Complementary Training

Belgrade, Serbia

2019

For information: www.complementarytraining.net

Jovanović, M.
Strength Training Manual. The Agile Periodization Approach. Volume Two

ISBN: 978-86-900803-1-1
978-86-900803-3-5 (Volume Two)

Cover design by Ricardo Marino

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E-Book design by Goran Smiljanić

Published in Belgrade, Serbia

First E-Book Edition

Complementary Training
Website: www.complementarytraining.net

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Preface to the Volume Two

When I started writing the Strength Training Manual, I wanted it to be a simple and short book with heuristics and reference tables. As I began to write, I soon realized that the readers will have hard time understanding how to actually apply those heuristics and tables, as well as understand the ***whys*** behind them. Additionally, writing is not a simple act of ***dumping*** material on paper for me, but rather an act of ***exploration*** and discovery. Therefore, as I wrote, new things emerged and I wanted to ***play*** with them, attack them from multiple perspectives to see how robust they are. In the end, this made the Strength Training Manual much larger and much slower to write than I originally intended.

The reasons why the Strength Training Manual e-book comes in volumes are as follows. First, I can split it in chunks, which, for those who embark on any writing adventure, is much more manageable. Second, I wanted this to be available to the readers as soon as possible, so that I can collect the feedback and improve the text for the potential paperback/hardback edition. Third, reading 600-page e-book is much harder than reading 200-something e-book. Fourth, the profit. E-book version of the Strength Training Manual published in volumes is available for free for the Complementary Training members, which makes it an additional benefit of the membership. In a nutshell, publishing in volumes seemed like a good idea and a solution. Only time will tell if I was right or wrong.

In this Volume Two, I am continuing with more practical application compared to more "philosophical" Volume One. Chapter 5a discusses topics of dose and response, while Chapter 5b continues with more practical application and reviews multiple set and rep schemes. Chapter 6 covers Review and Retrospective element of the Agile Periodization.

As always, I am looking forward to your critiques and feedback. Please do not hesitate to contact me if you have any questions or spot any kind of bullshit.

Mladen Jovanović

5a Planning

Before jumping into deep waters of strength planning, it is important to cover a few "Small World" models of the training *dose* and training *response* that are lurking behind all of our planning decisions.

Training dose

To make it distinctive from the term *training load*, which I have used to refer to the weight on the barbell (see Figure 4.1), I will use the term *training dose* to indicate a construct that represent some type of *stress* and/or *stimuli* that athlete experiences when training for strength (or training in general). That being said, it is really hard to have a precise definition of a training dose and to quantify it. It is particularly short sighted to represent training dose with a single metric. Thus, I will represent pluralist viewpoint by using multiple "Small World" models as potential tools.

Figure 5.1 contains hypothetical components of the training dose construct (keep in mind that this is also a "Small World" representation).

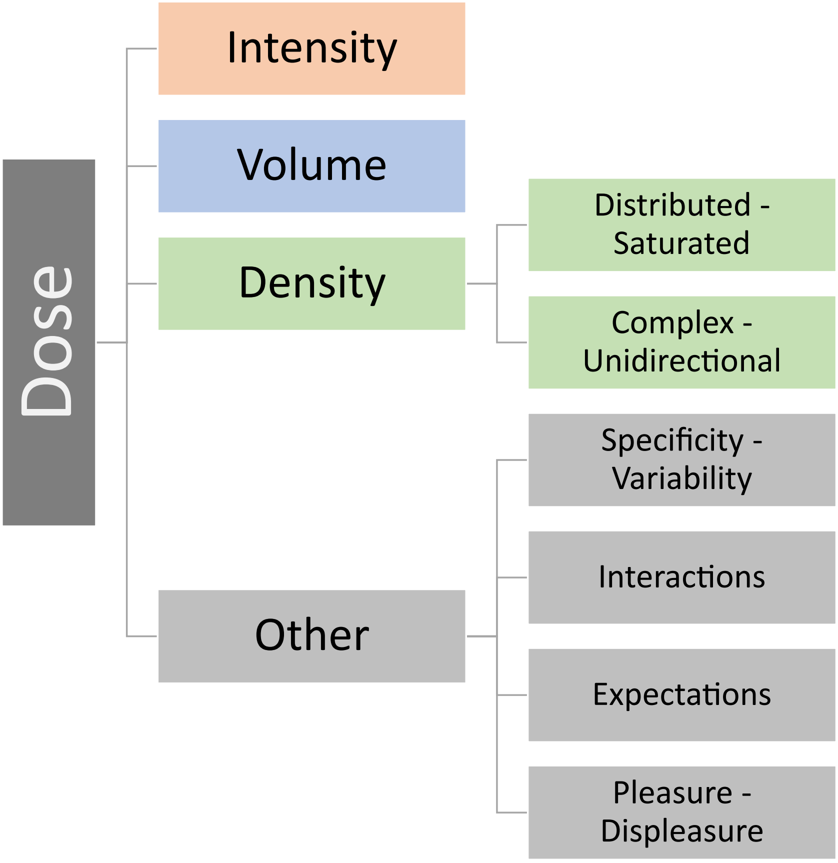


Figure 5.1. Training dose components

Intensity, Volume and Density

Simply, *Intensity* as a component of training dose represents *quality*, while *Volume* represents *quantity*. As explained in Chapter 4, intensity represents a complex interaction of (1) Load, (2) Exertion, and (3) Intent. For example, lifting 100kg (here 100kg could be considered "intensity") for 5 reps with maximal intent versus submaximal intent would represent qualitatively different training intensity and thus qualitatively different training dose. The same can be said for lifting 100kg for 3 with 3 reps in reserve, versus 1 rep in reserve. Intensity is usually represented with the average relative intensity metric (aRI) introduced in Chapter 4. Using relative intensity allows for comparison between exercises and individuals with different 1RM. For intra-individual monitoring of intensity, one can use average intensity (*aI*), which represents absolute load (in kilograms or pounds).

Volume represents quantity or amount of work done. As explained in Chapter 4, volume is usually expressed through number of lifts (NL), tonnage, impulse and INOL metric (as well as with novel metrics such as exertion load). In an ideal world, volume would be represented with work done in Joules, but mentioned metrics are satisficing proxies.

Intensity and volume can be *combined* by using "zoning", or providing volume metrics per intensity zone. For example, NL in 70-80%, 80-90% and 90%+ 1RM zones. But, a workout consisting of 3 x 10 @70% will have the same volume indices (and volume distribution) as workout consisting of 10 x 3 @70%, although we know experientially that these are qualitatively different. Chapter 4 introduced the novel "exertion load" (XL) metric which gives non-linear weighting of the reps depending on their proximity to failure (using RIR).

Volume metrics tend to use *intensity cut-off point* (e.g., not counting reps below certain %1RM) , which is usually around 50% of 1RM for grinding lifts. This depends if one uses dynamic effort method and wants to keep counting reps under 50% 1RM. It is thus important to clarify what this threshold is. For example, if someone says that the weekly NL for bench press was 50 lifts, it is natural to ask "What counts as a lift?" or in other words asking about the intensity cut-off point. The same is true for any other volume metric.

What about finishing 5x5 @80% workout in 10 minutes versus 15 or 20 minutes? These would have the same volume and intensity, but they would have different *density*. Mathematically or physically expressed, density can be considered a proxy to *average power*, since it is work done (or proxy metric to work done) divided by the time it takes to complete the work. As mentioned in Chapter 4, density metrics are not really common, but they could be particularly used in the *Mongoose Persistence* methods (e.g., muscular endurance, power endurance). The concept of density is also crucial element in Charles Staley's Escalatory Density Training (ESD) method (Staley, 2005).

Within quality saturation-distribution

Besides the above use, density is an interesting component of a training dose, particularly because it depends on the *time frame*, and thus expands into the concept of *distribution* of the training dose as well as *frequency* of training sessions (e.g., among how many training sessions a certain training dose is distributed). For example, in a given session one can distribute all particular lifts of one exercise into one time block (e.g., 5x5 @75% of Squats), or combine multiple exercises in a superset or a circuit fashion. In motor learning and skill acquisition, this is termed *blocked practice* versus *random practice (Davids, Button & Bennett, 2008; Renshaw, Davids & Savelsbergh, 2012; Chow et al., 2016; Farrow & Robertson, 2017)*. Blocked practice involves solving one particular task or performing single particular skill for blocked period of time. Random practice refers to randomly solving or performing multiple skills and tasks. It has been shown that from skill retention perspective[1], random practice is better. This could be a useful tip when coaching someone the basic skills of lifting (i.e., some type of superset, quad-set or even circuit could be better from motor learning perspective).

Across multiple days, training dose aimed at the given quality (or method) can be *distributed* or *saturated* (see Figure 5.2). I like to refer to this as *distribution-saturation* continuum or complementary pair.

Figure 5.2. Saturated-Distributed continuum of distributing training dose (using NL metric) of a single quality

1 Retention and performance needs to be differentiated. Good performance at training doesn't necessarily imply good retention, and vice versa. That is why sometimes one performs exercise perfectly in practice, comes back a few days later and it looks like he has never done it before (Davids, Button & Bennett, 2008).

Phase Potentiation is bullshit - but sequencing might not be

Normal continuation of the "saturate and separate" reasoning is the fallacy of following a particular sequence which is "optimal". Figure 5.5 depicts common sequences, usually referred to as *phase potentiation* (DeWeese et al., 2015a,b).

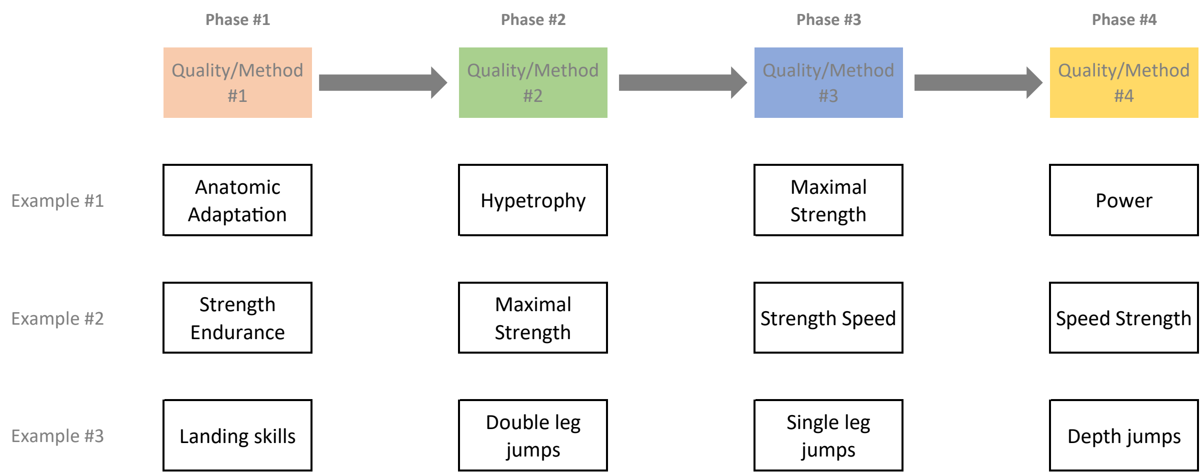


Figure 5.5. Phase potentiation is bullshit. You do not need to follow predetermined sequence of blocks as an ideology

The idea behind phase potentiation is that each block sets the stage and facilitates the effects of the block to come. I do agree that this is true, but the real world training is not a single sequence of phases, but sequence repeated multiple times over the years. Thus, marginal improvements when following a single "optimal" sequence are lost or negligible when sequence is repeated multiple times. It is thus stupid to force following a particular sequence just for the sake of "phase potentiation" and marginal gains. Besides, why would someone do, say hypertrophy phases if one doesn't need to bulk up? To potentiate the next maximum strength phase? It is stupid.

I had been following certain strength training phases as a young S&C coach in soccer, but then I had few athletes missing for a week or two (either due to injury or due to national training camp). This fucked up my sequence and I had a hard time "reintroducing" them to the group training (for example, they missed max strength phase, and had to jump to power phase with the rest of the group).

The "phase potentiation" proponents will bitch on me and argue that they had results following the particular sequence. First of all, I am not negating or questioning their results, but the rationale behind the phase potentiation. Second, the explanation of the mechanism behind "phase potentiation" could be simpler. Here is a simple game.

Assume I have a rule in my head that generates triplets (sequence of three numbers)[9]. Here is one triplet: *3 - 5 - 7*. You need to figure out the rule that generated the triplets by generating samples, while I will be telling you if they comply with the rule (i.e., correct or incorrect). Because you have seen 3 - 5 - 7 triplets, you assume that the rule is "N, N + 2, N + 4". This is called *prior* belief, or *hypothesis*. Let's test that belief (Table 5.3)

You guessed	Correct?
1, 3, 5	✓
4, 6, 8	✓
11, 13, 15	✓
7, 9 , 11	✓
18, 20, 22	✓

Table 5.3. You try to figure out the rule by generating triplets

Since my feedback complies with you hypothesis, you might conclude that the hypothesis is true and ask me "The rule must be N, N+2, N+4. Am I correct?". And I will answer: "No, you are not correct!."

In this simple example we can see Karl Popper's idea of *falsification* and your suffering from *confirmation bias*. Rather than trying to find examples that *falsify* your hypothesis, you continued looking for examples that confirms your hypothesis. This is not how science works and this is demarcation between science versus pseudoscience: science is always looking to falsify its theories and hypothesis. No matter how many correct triplets you generated, you are never certain that your hypothesis is correct, but one single incorrect example is enough to falsify your hypothesis. This is why I stated in Chapter 2 that Negative knowledge is more *robust* than Positive knowledge. Knowing what doesn't work is much more robust, than knowing what might work.

So what was the rule? The rule was "All different positive numbers!". Thus, all those claiming that results are better because they followed a particular sequence are suffering from the confirmation bias. Also, the *Occam's Razor* can be applied here, which states that the simplest explanation is the most probable one. In the case of phase potentiation, explanation is that *variability* is the probable cause rather than some optimal sequencing identified by the Russian scientist that was kept in secrecy during the Cold War.

I do think that certain sequences might be more suitable, although not due to phase potentiation. The particular sequence might be followed because one wants to (1) *minimize the Downside*, and (2) *gain upside with least stress or complexity*. For example,

9 This is usually called DGP or Data Generating Process in the statistical analysis. One of the goals of statistics is to 're-create' DGP from the sample and estimate uncertainty around estimates.

training, particularly when training novice athletes, we tend to start with say 3x10 @60% and proceed to 3x5 @75%, because we believe it is "progression" (in this case in intensity of load)[12]. But 3x10 can be more demanding on the client or the athlete due to higher exertion load (XL) and higher volume, which can make someone bloody sore and report higher levels of *discomfort*. This can cause your average soccer mom never to show in training anymore. And apparently you wanted to minimize the downside by following a progressive program (assuming the %1RM is a metric that needs to be "progressed"). Boom - busted! It is thus recommended for beginners to use Ballistic Load-Exertion table (see Chapter 4), which can promote quality reps and minimize fatigue and soreness and discomfort.

External vs Internal and subjective ratings of dose

Opening up the pleasure-displeasure can of worms needs additional elaboration. In theory, training dose can be represented with *external* and *internal* components. Things are becoming a bit blurry here, because internal dose can actually be considered acute psychophysiological response occurring during the execution of the exercise (i.e., external dose). This again reminds us that we are dealing with the "Small World" models. But anyway, let's assume external and internal are both components of a training dose.

Additional components of the training dose can be *objective* and *subjective* (Figure 5.6). Please note that "objective" component also have a bunch of "subjective" assumptions.

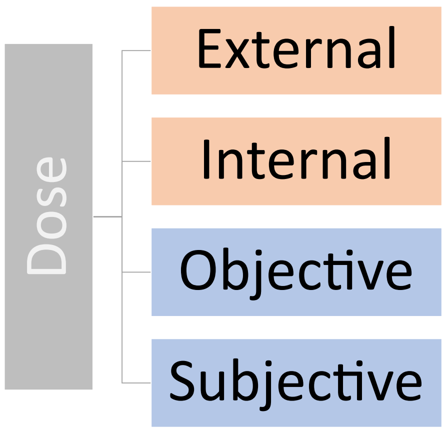


Figure 5.6. External and internal components of training dose

12 As you will soon read in this chapter, "progression" means making things "harder" and this tends to involve one or more training dose variables. In this particular example, making things harder is assumed to be %1RM. But that doesn't need to be the case...

Objective-subjective and external-internal dose components can form quadrants. Figure 5.7 contains example metrics for each quadrant.

	External	Internal
Objective	NL, Tonnage, Impulse, aRI, INOL, XL, Velocity, Velocity Loss, Power, Force...	EMG of the muscles, HR, skin conductance, bLA accumulation, ammonia and other metabolites or hormones...
Subjective	Someone else's, like coach's, subjective judgment of the dose	RIR, Exertion rating, Effort ratings, Discomfort ratings...

Figure 5.7. Training dose quadrant

External-Objective Dose

This quadrant represents metrics already explained in this and previous chapter.

Internal-Objective Dose

This quadrant consists of metrics that represent internal dose (or acute response) in the body. This could involve your common lab coat measurements, like EMG, blood lactate (bLA) and so forth. This represents how the body responds during the execution of the exercise (i.e. external-objective metrics).

External-Subjective

This quadrant consists of someone else's subjective ratings of the training dose. For example a coach or your training partner. Coach can observe the velocity of the barbell and make inferences about how tough was a given set or so forth. This dose estimation is usually not much discussed in the lab coats journals, but it is very important in the real world.

Internal-Subjective

Welcome to the lab coat shit show (Smirmaul, 2012; Halperin & Aviv, 2019; Jovanovic & Halperin, 2019). Seriously. This has been a source of confusion and useless research papers for years. And things are far from sorted out. I will not waste much paper here by reviewing all the mess. I suggest you check the recent unpublished paper (Halperin & Aviv, 2019) for a great and concise overview. I will rather provide some of my rationale and potential solutions (although by no means I consider this a finite model).

the guys from Juggernaut Training Systems also utilize the following thresholds and zones: (1) *Maintenance Volume (MV)*, (2) *Minimum Effective Volume (MEV)*, (3) *Maximum Adaptive Volume (MAV)*, (4) *Maximum Recoverable Volume (MRV)*. MV is related to MRD, MEV is equal to MED, MAV is equal to DED (although this can be defined as a point where plateau starts, or where there is the biggest difference between upside and downside), MRV is equal to MTD.

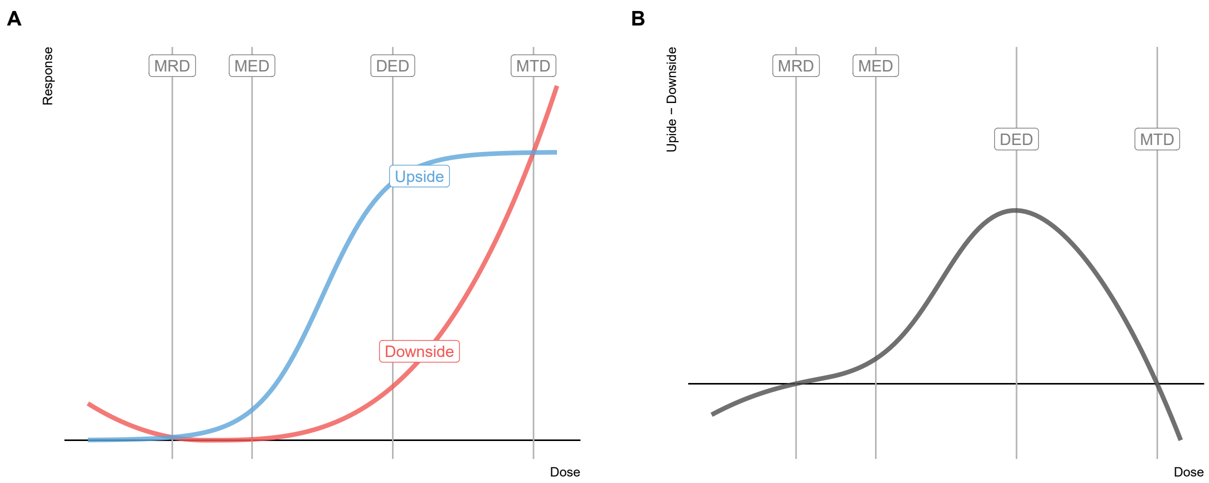


Figure 5.13. Hypothetical relationship between upside and downside. Panel A contains upside and downside as a separate curve, while panel B contains their difference. Vertical lines indicated different dose thresholds (see text for explanation)

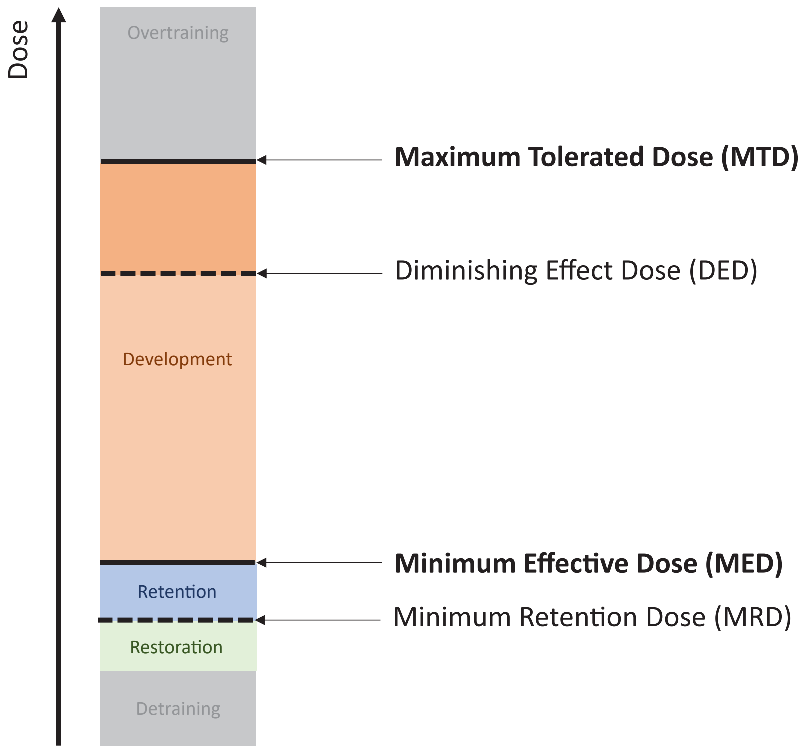


Figure 5.14 contains visual depiction of MRD, MED, DED and MTD, as well as recovery, retention and development zone.

peaking for a competition. Doesn't work (at least not for a long time). Which doesn't mean that this shouldn't be done, but it needs to be used sparingly and with a great awareness.

Another complementary pair that goes well with Push and Pull is develop vs express, or sharpen/saw. This is very similar to Habit 7 from "7 Habits of Highly Successful People" by Stephen Covey (Covey, 2013). We want our strength training to 'sharpen our saw', or to develop strength qualities, rather than to test them. We can look at pull approach as more 'developing' and push approach as more 'testing' or expressing what the athlete might have possessed already. But things are not black and white, and we utilize this develop/express complementary pair thorough our training program - we develop strength most of the time, but we occasionally 'test' (e.g. using plus sets) to check where we are. We do not want to test too frequently, and we do not want to avoid testing at all. They are embedded and interrelated.

Figure 5.23 contains the summary of the push and pull concepts discussed so far.

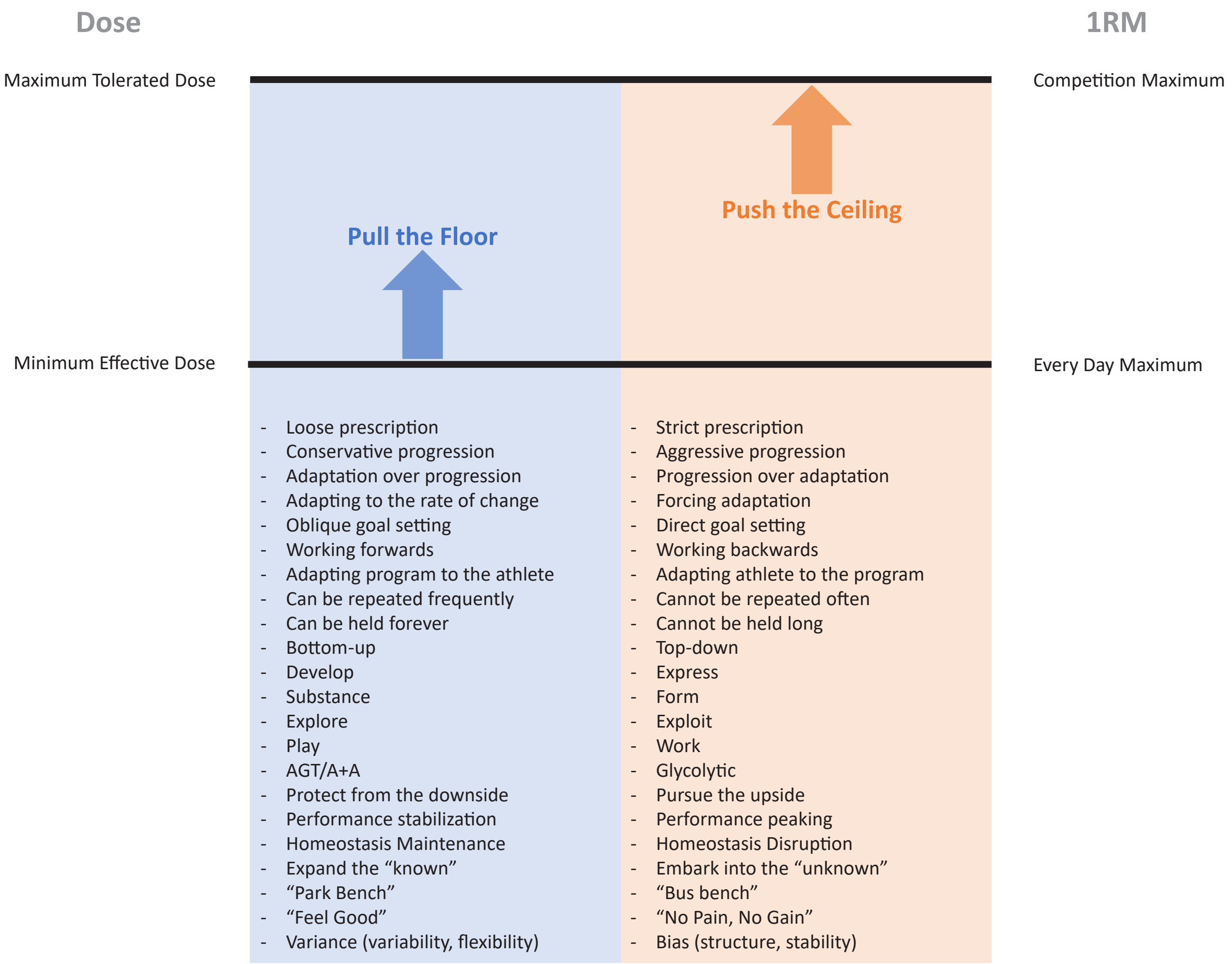


Figure 5.23. Pushing vs pulling concept

5b Planning (continued)

Previous chapter introduced theoretical concepts behind planning, using the dose-response "Small Worlds" and multiple complementary aspects of planning, culminating with the concepts of pull the floor and push the ceiling. In this chapter, these will be put into more concrete and pragmatic form for strength training.

The building block of this chapter will be *set and rep schemes*, that together with exercise (or mean) represent a *prescription unit* (Figure 5.26), or the smallest planning unit (i.e., *strength training atom*).

Figure 5.26. Prescription unit consists of exercises and set and rep schemes

Set and Rep Schemes: The Basis

Chapter 3 covered exercises and their classification. This chapter will delve more into set and rep schemes and combinatorics used in planning (e.g., vertical and horizontal planning as well as divisible and indivisible strategies and other novel planning strategies that will be discussed shortly). Before we even start with more advanced topics, let's cover the anatomy of a set and rep scheme.

Anatomy of a set and rep scheme

Figure 5.26 contains anatomy of a set and rep scheme. This is of course a simplification ("Small World"), but quite frequent and useful model. Every set and rep scheme consists of multiple components (i.e., sets), but what you find in most if not all strength training material are the *main sets*. This is unfortunate, since set and rep scheme is much more complex and richer construct.

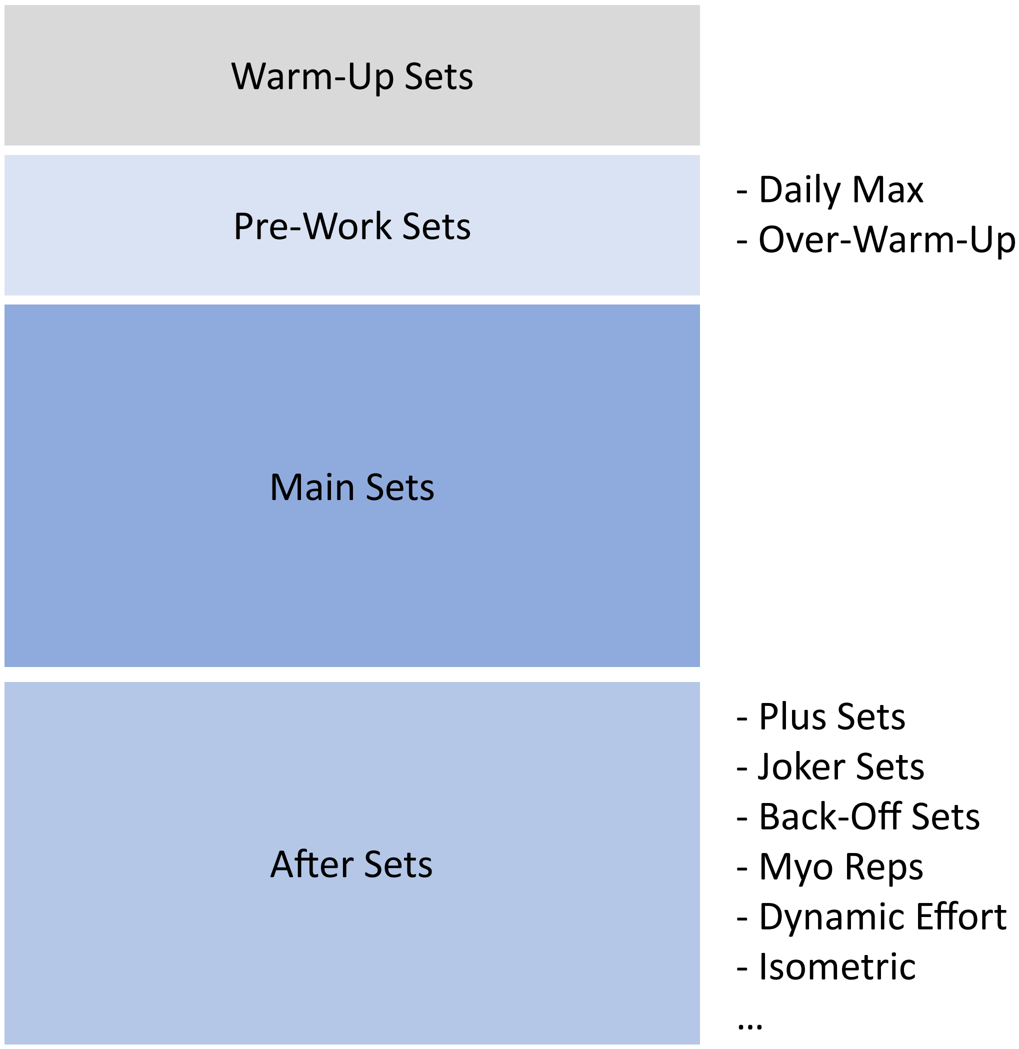


Figure 5.27. Anatomy of a set and rep scheme

Warm-up sets

Similarly to the discussion on active recovery means and methods in the previous chapter, I approach warm-ups differently. Rather than looking at warm-up as means to reach working temperature of the body and priming the nervous system only, one can look at warm-ups as affordance to practice and develop particular quality at the current state of the organism or athlete. I know this is a mouthful, but it simply means addressing what can be addressed while athlete is warming up. During the warm-up

Main or Working sets

These are bread-and-butter of the set and rep scheme. As such, they are considered in greater depth in this chapter and I won't delve much in them here. For the sake of completeness, Figure 5.28 consists of common prescription formats when it comes to set and rep schemes, particularly main sets.

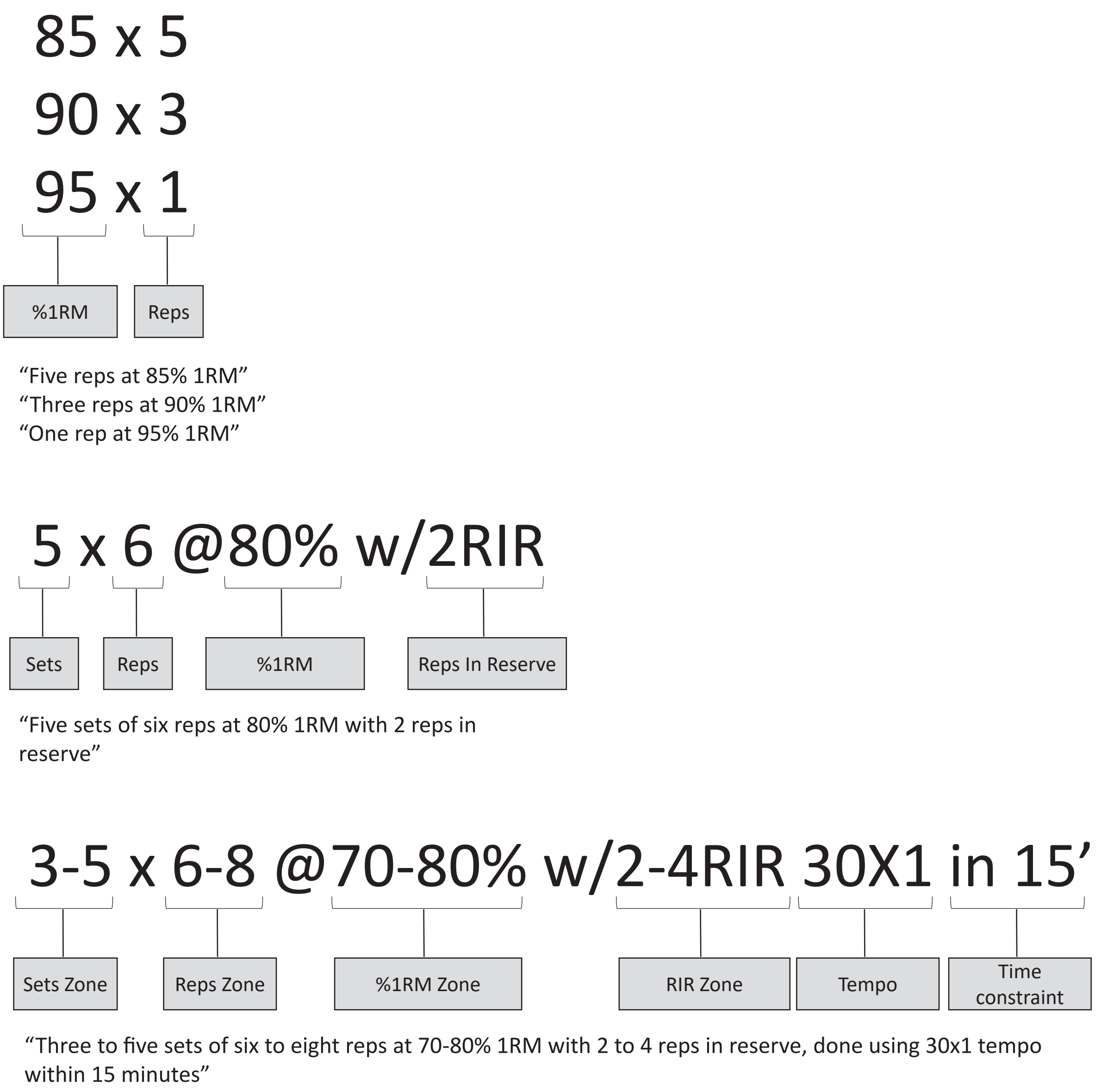


Figure 5.28. Common examples of the prescription format of the set and rep schemes

After sets

After sets represent additional opportunity and affordance in the workout and there are different implementations here. Let's cover the most common:

Plus sets. Plus sets involve finishing main sets with a set to failure (or to a particular ceiling, e.g., 10 reps max). Here is an example:

Classification of Set and Rep schemes

There are numerous criteria to classify set and rep scheme. Figure 5.33 contains the most common criteria to classify set and rep schemes.

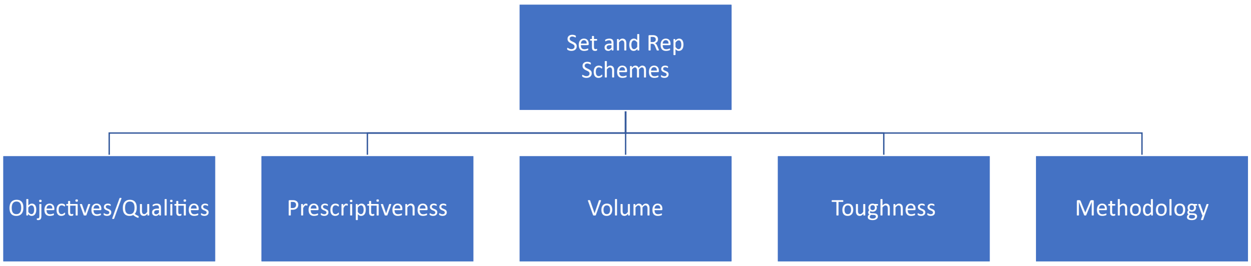


Figure 5.33. Classification criteria for Set and Rep Schemes

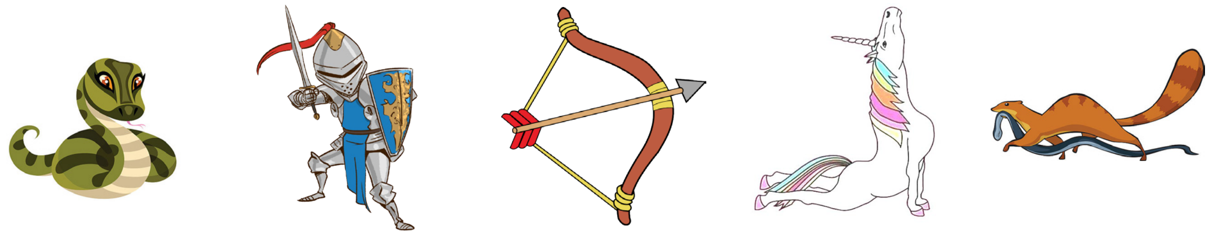
Classification based on Objectives or Qualities

As explained in Chapter 2, we tend to have simplistic models of which loading parameters target particular qualities (see Figure 2.4). Unfortunately, as depicted in the Figure 2.5 in Chapter 2, things are not that simple, and different methods can achieve the same objective, while single method can hit different training qualities. The causal network is quite complex, but it doesn't mean we can't have some guiding heuristics. The Agile Periodization utilizes an iterative approach which consists of: frequent reviews and embedded testing, MVPs and experimenting, as well as making sure that all the major 'buckets' are targeted. In short, one never puts all eggs in one basket, but rather experiments with multiple options to see which one works at any particular time.

Lab coats tend to favor simplistic proxy metric as a stimulus, which later influences the whole program design (i.e., to optimize for that particular metric, e.g., the optimal NL in a session, in a week, the optimal frequency, intensity zones and so forth). What is a stimulus for hypertrophy? Or to put it more clearly, what "Small World" dose metrics (see Dose -> Response in the previous chapter) are proxy to hypertrophy stimuli? What are for maximal strength development? I am not going to go into research behind this, but I highly recommend blog posts by Lyle McDonald on these topics (McDonald, 2007, 2008, 2009a,b,c, 2014a,b, 2015a,b, 2016, 2019a,b).

Besides listening to lab coats, one also (or probably more so) needs to listen to *bros* and coaches who have been *tinkering* in the field with their skin in the game to create *best practices* (refer to Figure 2.13). The material that follows is my attempt to collect some of those practices that can serve as a *prior* for your own experimentation. I again recommend very critical and thoughtful articles by Lyle McDonald on the topic.

Figure 5.34 contains highly speculative guidelines for a single session for targeting different qualities. How these are repeated and distributed in a week (or *sprint*) can vary highly based on preferences, time limitations and so forth. There are some guidelines for frequency and weekly NL, but for this I direct you to Lyle McDonald's blog posts. As already pointed multiple times in this manual, one should use these guidelines as priors and experiment around them.



	Anaconda Strength	Armor Building	Arrow	Vanilla Training	Mongoose Persistence
%1RM	80+% 1RM	65-85% 1RM	<70% 1RM	<40% 1RM	<40-60% 1RM
Reps	1-5 reps	5-12 reps	1-10 reps (usually <6)	10-20 reps (or more)	15-30 reps (highly variable)
Volume	10-20 total reps	25-50 total reps	10-30 total reps	50-100 total reps	100+ total reps

Figure 5.34. Suggested HIGHLY-SPECULATIVE loading parameters per training objective

Recommendations in the Figure 4.34 are very crude rules of thumb. For example, in the Arrow category (explosive strength), one can perform 10-20 reps per set when it comes to KB Swings, with the total volume of 100-300 reps. Also, one can perform Olympic lifting with 80%+ 1RM, while the Arrow category suggests <70%. So take these recommendations with a grain of salt. A lot of it.

Based on these recommendations, set and reps schemes can be classified depending on which quality they (predominantly) target. This is of course hard, but can serve as a general guideline.

As opposed to classifying set and rep schemes based on the target quality, one can classify them based on *methodology*[21] (I will present my own system later in this

21 I wasn't sure whether to call this methodology or phenomenology, but the point is classifying set and rep schemes based on observable and controllable qualities, rather than target qualities.

chapter). Tables 5.9 and 5.10 contains Joe Kenn's Tier System (Kenn, 2003) guidelines for different intensity cycles (which can be considered *methodology*).

Strength Cycle	Training Range	Olympic Lifting Reps per Set*	Olympic Lifting Volume*	Upper/Lower Body Reps per Set	Upper/Lower Body Volume
General Conditioning	60% - 67.5%	6	18	10	30
Strength Endurance	60% - 67.5% 70% - 77.5%	5 - 6 4 - 6	30 24	12 - 15 8 - 10	60 - 90 40 - 60
Developmental Strength	70% - 77.5% 80% - 87.5	4 - 6 2 - 4	24 20	6 - 10 3 - 6	20 - 48 12 - 30
Metabolic Strength	80% - 87.5% 90% - 95%	Cluster Cluster	20 10	Cluster Cluster	15 - 30 10 - 15
Explosive Strength*	55% - 65% 70% - 75%	3 - 6 3 - 6	18 - 30 12 - 24	3 - 6 3-6	18 - 30 12 - 24
Maximum Strength	90+%	1 - 2 or Multiple Rep Max	10-Apr	1 - 3 or Multiple Rep Max	3 - 12

Table 5.9. Joe Kenn's basic intensity cycles for foundation exercises (main exercises). Reproduced with permission by Joe Kenn.

Strength cycle from Table 5.9 can be considered target *quality*, although Joe Kenn also provides different methodological set and rep schemes (see "Stable 3", "Descending", "Advanced", "Progressive", "Clusters", "Prilepin" in Table 5.10) that are utilized for a given strength cycle (quality).

General Conditioning Stable 3	**Strength Endurance** Descending	**Strength** Advanced	**Maximum Strength** Progressive	**Metabolic Strength** Clusters	**Explosive Strength** Prilepin
65% x 10	65.0% x 12	82.5% x 4	67.5% x 3	82.5% x (1+1+1+1)	75% x 3
65% x 10	62.5% x 12	82.5% x 4	72.5% x 3	82.5% x (1+1+1+1)	75% x 3
65% x 10	60.0% x 12	82.5% x 4	77.5% x 3	82.5% x (1+1+1+1)	75% x 3
	57.5% x 12	82.5% x 4	82.5% x 5	82.5% x (1+1+1+1)	75% x 3
	55.0% x 12	82.5% x 4	82.5% x 5	82.5% x (1+1+1+1)	75% x 3
	52.5% x 12	82.5% x 4	82.5% x 5	82.5% x (1+1+1+1)	75% x 3
					75% x 3
					75% x 3

Table 5.10. Joe Kenn's sample set and rep schemes for particular intensity cycle. Reproduced with permission by Joe Kenn.

Joe Kenn also relies heavily on the Prilepin Table (see Table 4.35) that gives volume recommendations for Olympic lifting, which can be also useful for all ballistic movements and when one wants to focus on quality execution of the grinding lifts and limiting unnecessary fatigue (without the novel fancy velocity drop metrics). Please note that Prilepin Table is quite similar to Ballistic Load-Exertion table (see Table 4.37), but also offers workout volume recommendation guidelines.

Table 5.11 contains Matt Jordan's (Canadian Sport Institute in Calgary) excellent classification of strength training methods. Please note the distinction between "Strength Method" (i.e., *method*) and "Target Strength Ability" (i.e., *quality*).

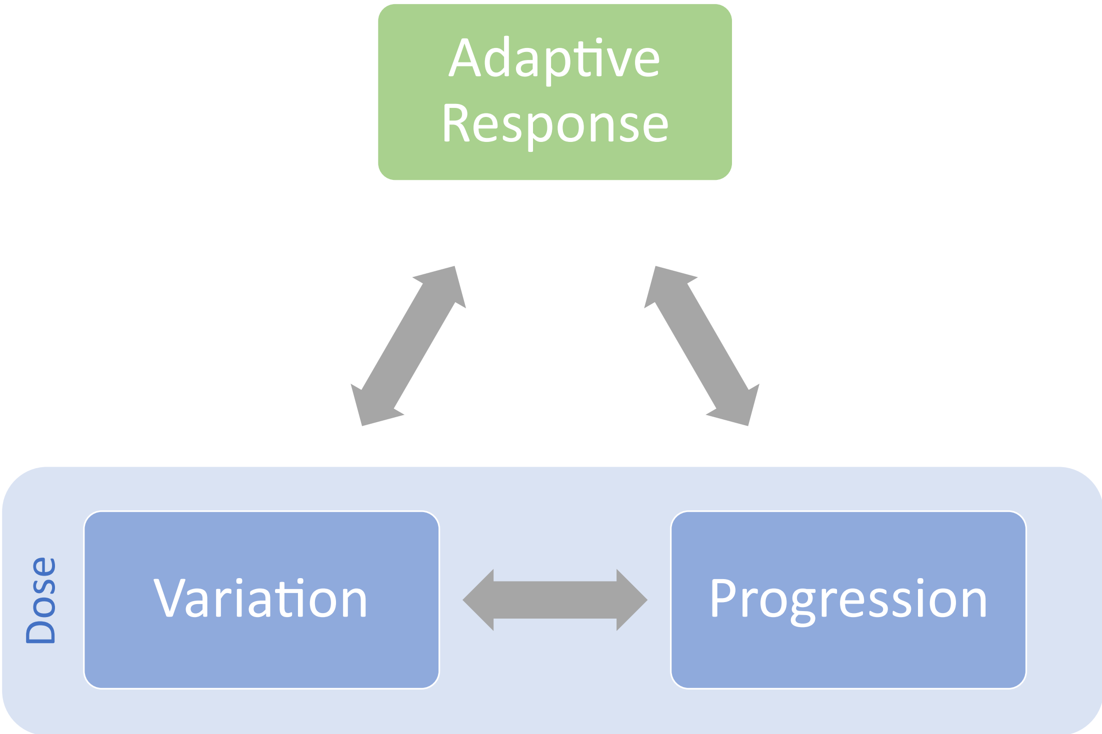


Figure 5.37. Variation and Progression are hardly distinguishable but necessary components of the dose construct.

Vertical and Horizontal planning

Let's assume you have two days a week (bottom-up approach) to train the bench press (or upper body horizontal pushing movement): Monday and Thursday. For the sake of example, let's assume that the Monday workout is bench press *3x10 @60%* (Table 5.14).

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Week 1	**Bench Press** 3x10 @60%			?Bench Press? ???			
Week 2	?Bench Press? ???			?Bench Press? ???			
Week 3	?Bench Press? ???			?Bench Press? ???			
Week 4	?Bench Press? ???			?Bench Press? ???			

Table 5.14. Two days a week to train the bench press. The question is how to plan?

The question is how to *vary* this workout on Thursday, and how to *progress* both of them across weeks? As already explained, this progress vs. variation is very tricky, so it is better to refer to this problem as *horizontal* and *vertical* planning (Table 5.15). Horizontal planning is more leaning towards variation, while vertical planning is leaning more towards progression. This doesn't need to be the case all the time, but a general rule (and might be easier to grasp the concept of horizontal and vertical planning) that can be, and usually is, broken.

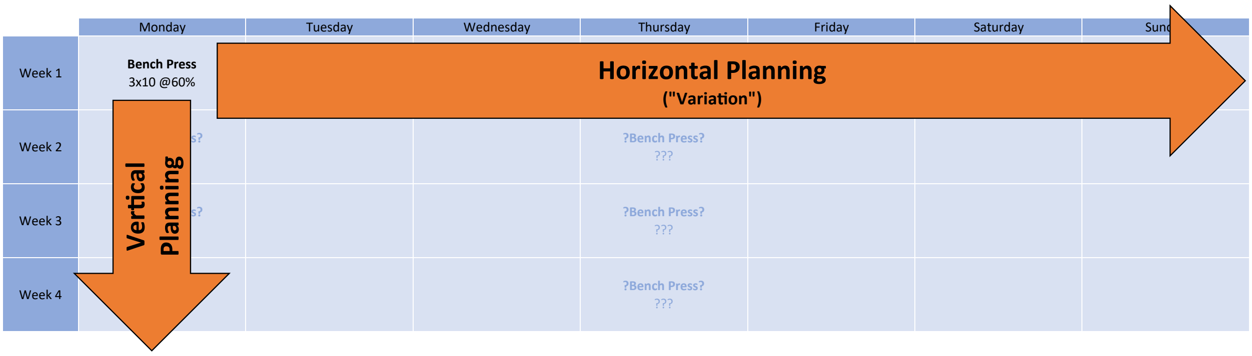


Table 5.15. Horizontal and vertical planning

Horizontal planning

Horizontal planning, usually represents varying a workout that is within the same *progression stage* (although, as will be seen in a few paragraphs, doesn't need to be the case). Dan Baker (Baker, 2007) provided an example table of variations that could be utilized when two similar workouts are performed in one week (Table 5.16)

Method of variation	Day 1 example	Day 2 example
1. Same exercises, same RIR, increase in number of reps	Bench Press 3x10 @70% w/3RIR	Bench Press 3x15 @63% w/3RIR
2. Same exercises, same RIR, decrease in number of sets	Bench Press 4x10 @70% w/3RIR	Bench Press 2x10 @70% w/3RIR
3. Same exercises, sets, and repetitions, reduce the lifting speed and load.	Bench Press 3x10 @70% w/3RIR 20X1	Bench Press 3x10 @60% w/10RIR 42X1
4. Same exercises and other variables, decrease rest periods and resistance	Bench Press 3x10 @70% w/3RIR R:3min	Bench Press 3x10 @60% w/10RIR R:1min
5. Same exercises and other variables, decrease resistance.	Bench Press 3x10 @70% w/3RIR	Bench Press 3x10 @60% w/10RIR
6. Same exercises and other variables, decrease repetitions.	Bench Press 3x10 @70% w/3RIR	Bench Press 3x6 @70% w/7RIR
7. Different strength exercises, but same for all other variables (same %1RM).	Bench Press 3x10 @70% w/3RIR	Incline Press 3x10 @70% w/3RIR
8. Perform a strength and power version of aligned exercises on different days.	Bench Press 3x5 @80% w/3RIR	Bench Throw 3x5 @40%
9. Perform heavier and lighter versions of aligned power exercises on different days.	Power Clean 3x5 @70%	Power Snatch 3x5 @70%

Table 5.16. Few examples of altering training workout within a week.
Reproduced with permission by Dan Baker (Baker, 2007)

contains example of vertical planning by Dan Baker (Baker, 2007) (although he calls is "different variants or patterns of strength training periodization").

Week	1	2	3	4	5	6	7	8	9	10	11	12
Subtle linear	3x13 @63%	3x12 @66%	3x11 @69%	3x10 @72%	3x9 @75%	3x8 @78%	3x7 @81%	3x6 @84%	3x5 @87%	3x4 @90%	3x3 @93%	3x2 @96%
Block with linear intensification	4x10 @60%	4x10 @64%	4x10 @68%	4x10 @70%	4x5 @78%	4x5 @81%	4x5 @83%	4x5 @85%	3x3 @88%	3x3 @90%	3x3 @92%	3x3 @94%
Block with nonlinear intensification	4x10 @64%	4x10 @68%	4x10 @70%	4x10 @66%	4x5 @80%	4x5 @83%	4x5 @85%	4x5 @75%	3x3 @90	3x3 @92%	3x3 @94%	3x3 @80%
Undulating	4x10 @64%	4x10 @68%	4x6 @76%	4x6 @80%	4x8 @72%	4x8 @76%	4x4 @84%	4x4 @88%	3x6 @82%	3x6 @85%	3x3 @92%	3x3 @94%
Wave-like	4x10 @64%	4x8 @70%	4x6 @76%	4x4 @82%	4x9 @70%	4x7 @76%	4x5 @82%	4x3 @88%	3x8 @78%	3x6 @84%	3x4 @90%	3x3 @94%
Accumulation/Intensification	6x3 @80%	6x4 @80%	6x5 @80%	6x6 @80%	5x5 @85%	4x4 @90%	3x3 @95%	2x2 @100%	-	-	-	-

Table 5.23. Dan Baker's different variants or patterns of strength training periodization. Modified with permission by Dan Baker (Baker, 2007)

Over the years, Dan Baker leaned more towards "wave" approach to vertical planning *(Baker, 2013)*. Table 5.24 contains Dan's most common wave set and rep schemes.

Vertical planning pretty much revolves around making things harder or tougher across time. Having said that, this is done by adjusting certain dose parameters or planning components (see Table 5.12 for more examples). The point is that both horizontal and vertical planning can utilize different set and rep scheme classification criteria (see Figure 5.33) , different dose components (e.g. saturated - distributed, complex - unidirectional), as well as different exercises. Vertical planning and horizontal planning represent "bottom-up" applications (as well as "forum for action") of "top-down" principles covered so far.

Although there are numerous approaches to vertical planning, in this manual I've used the two *progression* approaches, where either %1RM is what is being progressed across weeks, or proximity to failure (RIR). This is "Small World" model, and I am more than aware of it, so please be free to modify it to suit your needs, or use something else altogether.

Using Load-Exertion Table (Table 4.3), and Ballistic Load-Exertion Table (Table 4.37), two approaches that I named *Perc Drop* and *RIR Inc* are implemented as methods for vertical planning.

	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Wave 1	55 x 15	62.5 x 12	70 x 10	77.5 x 8	55 x 15	62.5 x 12	70 x 10	77.5 x 8
Hypertrophy exercises and/or Low level athletes	55 x 15	62.5 x 12	70 x 10	77.5 x 8	55 x 15	62.5 x 12	70 x 10	77.5 x 8
	55 x 15	62.5 x 12	70 x 10	77.5 x 8+	55 x 15	62.5 x 12	70 x 10	77.5 x 8+
Wave 2	60 x 12	67.5 x 10	75 x 8	82.5 x 6	60 x 12	67.5 x 10	75 x 8	82.5 x 6
Hypertrophy exercises and/or Intermediate level athletes	60 x 12	67.5 x 10	75 x 8	82.5 x 6	60 x 12	67.5 x 10	75 x 8	82.5 x 6
	60 x 12	67.5 x 10	75 x 8+	82.5 x 6+	60 x 12	67.5 x 10	75 x 8+	82.5 x 6+
Wave 3	65 x 10	72.5 x 8	80 x 6	85 x 5	65 x 10	72.5 x 8	80 x 6	85 x 5
Secondary Strength exercises Intermediates & Advanced athletes	65 x 10	72.5 x 8	80 x 6	85 x 5	65 x 10	72.5 x 8	80 x 6	85 x 5
	65 x 10	72.5 x 8	80 x 6+	85 x 5+	65 x 10	72.5 x 8	80 x 6+	85 x 5+
Wave 4	70 x 8	70 x 8	72 x 6	76 x 5	70 x 8	70 x 8	72 x 6	76 x 5
Primary strength exercises Intermediates & Advanced	70 x 8	75 x 6	80 x 5	84 x 3	70 x 8	75 x 6	80 x 5	84 x 3
	70 x 8	80 x 5	88 x 3+	92 x 2+	70 x 8	80 x 5	88 x 3+	92 x 2+
Wave 5	70 x 8	70 x 5	72 x 3	76 x 2	70 x 8	70 x 5	76 x 3	80 x 2
Primary strength exercises Intermediates & Advanced, using band/chains for ME weeks	70 x 8	75 x 5	80 x 3	84 x 2	70 x 8	75 x 5	84 x 3	88 x 2
	70 x 8	80 x 5	88 x 3+	92 x 2+	70 x 8	80 x 5	90 x 3+	94 x 2+
Wave 6	70 x 5	70 x 4	72 x3	76 x 2	70 x 5	70 x 4	76 x3	80 x 2
Primary strength & Olympic exercises, more advanced athletes	70 x 5	75 x 4	80 x 3	84 x 2	70 x 5	75 x 4	84 x 3	88 x 2
	70 x 5	80 x 4	88 x 3+	92 x 2+	70 x 5	80 x 4	90 x 3+	94 x 2+

Reference: Baker D. 2013. The Effectiveness of the Wave-Cycle for In-Season Training: 20 Years of Evidence on the In-Season Maintenance of Strength and Power in Professional Athletes.

Table 5.24. Dan Baker's different variants of wave set and rep schemes.. Modified with permission by Dan Baker (Baker, 2013)

Perc Drop approach

Perc Drop stand for percent (%1RM) drop. Table 5.25 contains two tables, top and bottom. Top table is used to calculate percent drop when going through four progression stages (where the Progression #4 is the toughest and Progression #1 is easiest). There are few heuristics implemented here. The first heuristic is that percent drop increases from low reps (-2.5% for 1 rep in a set) to high reps (-5% for 12 reps in a set). The second heuristic is that extensive set and rep schemes (i.e., those with more that 5 working sets) need higher percent drop than more intensive set and rep schemes[26].

Once the top table is calculated, the established percentage drops are applied to Load-Exertion table, which results in the bottom reference table on Table 5.25. The bottom table is then utilized to vertically plan (i.e., progress) various set and rep schemes through three to four progression steps.

26 This can be more of an art than science though. It is up to you to decide what is extensive and what is intensive given your context. When in doubt, lean on the lower percentage.

Reps	%1RM	Progression #4 Intensive	Progression #4 Normal	Progression #4 Extensive	Progression #3 Intensive	Progression #3 Normal	Progression #3 Extensive	Progression #2 Intensive	Progression #2 Normal	Progression #2 Extensive	Progression #1 Intensive	Progression #1 Normal	Progression #1 Extensive	Perc Dec
1	100%	0.0%	-2.5%	-5.0%	-2.5%	-5.0%	-7.5%	-5.0%	-7.5%	-10.0%	-7.5%	-10.0%	-12.5%	-2.50%
2	94%	0.0%	-2.7%	-5.5%	-2.7%	-5.5%	-8.2%	-5.5%	-8.2%	-10.9%	-8.2%	-10.9%	-13.6%	-2.73%
3	91%	0.0%	-3.0%	-5.9%	-3.0%	-5.9%	-8.9%	-5.9%	-8.9%	-11.8%	-8.9%	-11.8%	-14.8%	-2.95%
4	88%	0.0%	-3.2%	-6.4%	-3.2%	-6.4%	-9.5%	-6.4%	-9.5%	-12.7%	-9.5%	-12.7%	-15.9%	-3.18%
5	86%	0.0%	-3.4%	-6.8%	-3.4%	-6.8%	-10.2%	-6.8%	-10.2%	-13.6%	-10.2%	-13.6%	-17.0%	-3.41%
6	83%	0.0%	-3.6%	-7.3%	-3.6%	-7.3%	-10.9%	-7.3%	-10.9%	-14.5%	-10.9%	-14.5%	-18.2%	-3.64%
7	81%	0.0%	-3.9%	-7.7%	-3.9%	-7.7%	-11.6%	-7.7%	-11.6%	-15.5%	-11.6%	-15.5%	-19.3%	-3.86%
8	79%	0.0%	-4.1%	-8.2%	-4.1%	-8.2%	-12.3%	-8.2%	-12.3%	-16.4%	-12.3%	-16.4%	-20.5%	-4.09%
9	77%	0.0%	-4.3%	-8.6%	-4.3%	-8.6%	-13.0%	-8.6%	-13.0%	-17.3%	-13.0%	-17.3%	-21.6%	-4.32%
10	75%	0.0%	-4.5%	-9.1%	-4.5%	-9.1%	-13.6%	-9.1%	-13.6%	-18.2%	-13.6%	-18.2%	-22.7%	-4.55%
11	73%	0.0%	-4.8%	-9.5%	-4.8%	-9.5%	-14.3%	-9.5%	-14.3%	-19.1%	-14.3%	-19.1%	-23.9%	-4.77%
12	71%	0.0%	-5.0%	-10.0%	-5.0%	-10.0%	-15.0%	-10.0%	-15.0%	-20.0%	-15.0%	-20.0%	-25.0%	-5.00%

Reps	%1RM	Progression #4 Intensive	Progression #4 Normal	Progression #4 Extensive	Progression #3 Intensive	Progression #3 Normal	Progression #3 Extensive	Progression #2 Intensive	Progression #2 Normal	Progression #2 Extensive	Progression #1 Intensive	Progression #1 Normal	Progression #1 Extensive
1	100%	100%	98%	95%	98%	95%	93%	95%	93%	90%	93%	90%	88%
2	94%	94%	91%	89%	91%	89%	86%	89%	86%	83%	86%	83%	80%
3	91%	91%	88%	85%	88%	85%	82%	85%	82%	79%	82%	79%	76%
4	88%	88%	85%	82%	85%	82%	78%	82%	78%	75%	78%	75%	72%
5	86%	86%	83%	79%	83%	79%	76%	79%	76%	72%	76%	72%	69%
6	83%	83%	79%	76%	79%	76%	72%	76%	72%	68%	72%	68%	65%
7	81%	81%	77%	73%	77%	73%	69%	73%	69%	66%	69%	66%	62%
8	79%	79%	75%	71%	75%	71%	67%	71%	67%	63%	67%	63%	59%
9	77%	77%	73%	68%	73%	68%	64%	68%	64%	60%	64%	60%	55%
10	75%	75%	70%	66%	70%	66%	61%	66%	61%	57%	61%	57%	52%
11	73%	73%	68%	63%	68%	63%	59%	63%	59%	54%	59%	54%	49%
12	71%	71%	66%	61%	66%	61%	56%	61%	56%	51%	56%	51%	46%

Table 5.25. Perc Drop approach for planning grinding set and rep schemes

Here is an example of 3x10 and 3x3 schemes, using intensive and extensive variants calculated utilizing Perc Drop approach (Table 5.26).

			Progression			
Scheme	max %1RM	Variant	#1	#2	#3	#4
1x10	75%	Intensive	61%	66%	70%	75%
3x10	75%	Normal	57%	61%	66%	70%
6x10	75%	Extensive	52%	57%	61%	66%
1x3	91%	Intensive	82%	85%	88%	91%
3x3	91%	Normal	79%	82%	85%	88%
6x3	91%	Extensive	76%	79%	82%	85%

Table 5.26. Example vertical planning (progressions) for 3x10 and 3x3 scheme using Perc Drop method

Perc Drop is also applied on the Ballistic Load-Exertion table (Table 5.27) which is used for planning ballistic lifts or high-quality sets (without too much drop in velocity and quality of reps) as well as for beginners or in-season athletes (to avoid soreness).

Figure 5.39a and Figure 5.39b depict conceptual changes in %1RM, number of reps and number of sets across four progression steps implemented in each vertical planning method.

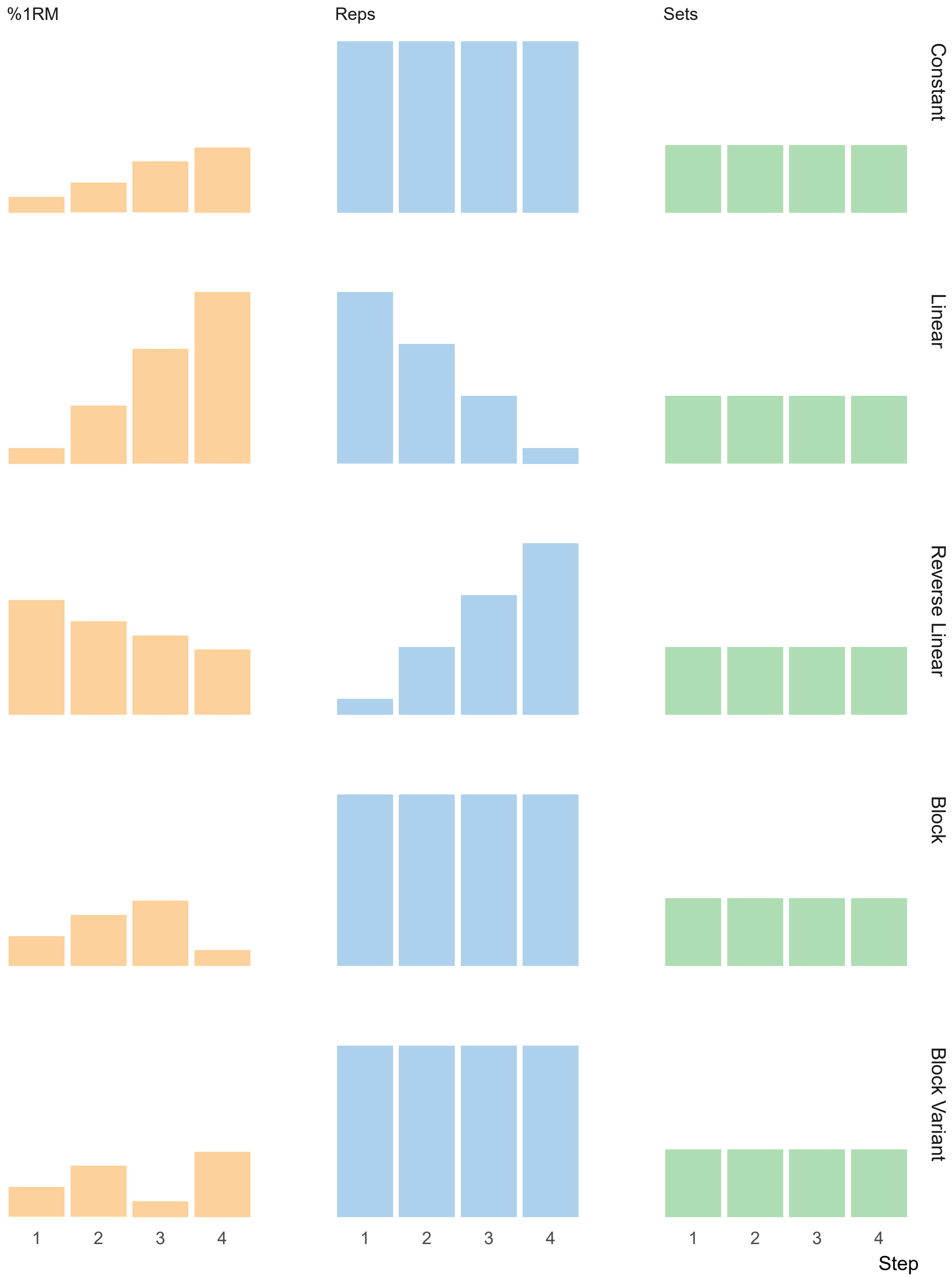


Figure 5.39a. Conceptual changes in %1RM, number of reps and number of sets across four progression steps implemented in each vertical planning method

Set and Rep Scheme	Step 1 %1RM	Step 1 Reps	Step 2 %1RM	Step 2 Reps	Step 3 %1RM	Step 3 Reps	Step 4 %1RM	Step 4 Reps
Plateau	59%	10	61%	10	64%	10	66%	10
	59%	10	61%	10	64%	10	66%	10
	59%	10	61%	10	64%	10	66%	10
	59%	10	61%	10	64%	10	66%	10
Step	36%	10	39%	10	42%	10	45%	10
	46%	10	49%	10	52%	10	55%	10
	56%	10	59%	10	62%	10	65%	10
	66%	10	69%	10	72%	10	75%	10
Reverse Step	66%	10	69%	10	72%	10	75%	10
	56%	10	59%	10	62%	10	65%	10
	46%	10	49%	10	52%	10	55%	10
	36%	10	39%	10	42%	10	45%	10
Ascending Wave	59%	10	61%	10	64%	10	66%	10
	63%	8	65%	8	68%	8	71%	8
	68%	6	70%	6	73%	6	75%	6
Descending Wave	68%	6	70%	6	73%	6	75%	6
	63%	8	65%	8	68%	8	71%	8
	59%	10	61%	10	64%	10	66%	10
Ascending Ladder	62%	2	65%	2	68%	2	70%	2
	62%	3	65%	3	68%	3	70%	3
	62%	5	65%	5	68%	5	70%	5
	62%	10	65%	10	68%	10	70%	10
Descending Ladder	62%	10	65%	10	68%	10	70%	10
	62%	5	65%	5	68%	5	70%	5
	62%	3	65%	3	68%	3	70%	3
	62%	2	65%	2	68%	2	70%	2
Traditional Pyramid	59%	10	61%	10	64%	10	66%	10
	63%	8	65%	8	68%	8	71%	8
	68%	6	70%	6	73%	6	75%	6
	63%	8	65%	8	68%	8	71%	8
	59%	10	61%	10	64%	10	66%	10
Reverse Pyramid	68%	6	70%	6	73%	6	75%	6
	63%	8	65%	8	68%	8	71%	8
	59%	10	61%	10	64%	10	66%	10
	63%	8	65%	8	68%	8	71%	8
	68%	6	70%	6	73%	6	75%	6
Light-Heavy	62%	10	65%	10	68%	10	70%	10
	52%	5	55%	5	58%	5	60%	5
	62%	10	65%	10	68%	10	70%	10
	52%	5	55%	5	58%	5	60%	5
	62%	10	65%	10	68%	10	70%	10
Cluster	66%	8 (5x3)	69%	8 (5x3)	72%	8 (5x3)	75%	8 (5x3)
	66%	8 (5x3)	69%	8 (5x3)	72%	8 (5x3)	75%	8 (5x3)
	66%	8 (5x3)	69%	8 (5x3)	72%	8 (5x3)	75%	8 (5x3)
	66%	8 (5x3)	69%	8 (5x3)	72%	8 (5x3)	75%	8 (5x3)
Cluster Wave	66%	8 (5x3)	69%	8 (5x3)	72%	8 (5x3)	75%	8 (5x3)
	69%	7 (4x3)	71%	7 (4x3)	74%	7 (4x3)	77%	7 (4x3)
	71%	6 (6x2)	74%	6 (6x2)	76%	6 (6x2)	79%	6 (6x2)

Table 5.35. Mladen's Methodological System of classifying Set and Rep schemes.

Cluster method

Cluster and Rest-Pause methods represent multitude variations and approaches and I suggest checking a paper by Tufano *et al.* for a great overview (Tufano, Brown & Haff, 2017). In short, Clusters and Rest-Pause involve *intra-set* pause (Figure 5.40).

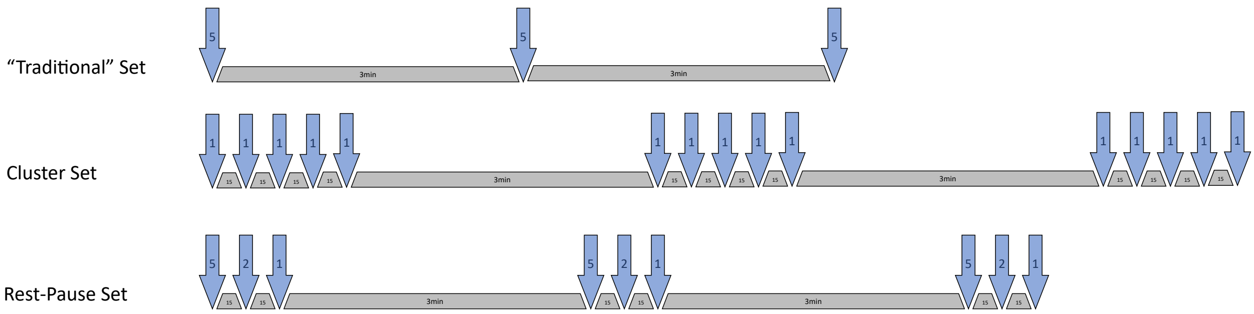


Figure 5.40. Traditional set, cluster set and rest-pause set. Modified based on the graphs in (Tufano, Brown & Haff, 2017).

Aside from the agreement between coaches and lab coats, that the Clusters and the Rest-Pause involve intra-set rest, everything else is murky water and differs from coach to coach, lab coat to lab coat. For example, take 3x5 @80% as a *traditional* set performed with various Cluster and Rest-Pause variations (Table 5.51).

<table>
<tr><th>Set Type</th><th>Prescription</th><th>Visual</th><th>Note</th></tr>
<tr><td>Traditional set</td><td>3x5 @85% RR:3min</td><td>|||||-----------|||||-----------|||||</td><td>Traditional set, in this case 3 sets of 5 to failure (0RIR)</td></tr>
<tr><td>Cluster #1</td><td>3x[5x1 R:15sec] @85% RR:3min</td><td>|-|-|-|-|-----------|-|-|-|-|-----------|-|-|-|-|</td><td>Singles for equal number of reps (i.e. 5 reps)</td></tr>
<tr><td>Cluster #2</td><td>3x[8x1 R:15sec] @85% RR:3min</td><td>|-|-|-|-|-|-|-|-----------|-|-|-|-|-|-|-|-----------|-|-|-|-|-|-|-|</td><td>Singles for 1.5 - 2x number of reps (i.e., 7 to 10 reps) in a set</td></tr>
<tr><td>Cluster #3</td><td>3x[4x2 R:15sec] @85% RR:3min</td><td>||-||-||-||-----------||-||-||-||-----------||-||-||-||</td><td>Doubles or tripples for 1.5 - 2x number of reps in a set</td></tr>
<tr><td>Cluster #4</td><td>15x1 @85% RR:30sec</td><td>|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|</td><td>Rest redistribution (see Time and Rep constraints method)</td></tr>
<tr><td>Cluster #5</td><td>7x2 @85% RR:60sec</td><td>||----||----||----||----||----||----||</td><td>Rest redistribution (see Time and Rep constraints method)</td></tr>
<tr><td>Cluster #6</td><td>5x3 @85% RR:90sec</td><td>|||------|||------|||------|||------|||</td><td>Rest redistribution (see Time and Rep constraints method)</td></tr>
<tr><td>Cluster #7</td><td>15 reps @85% in 8min</td><td>|||---||--|-------|||---|--|--|---||--|</td><td>Time and Rep constraints method (athlete self selects)</td></tr>
<tr><td>Rest-Pause #1</td><td>3x[5F+2F+1F+1F+F R:15sec] @85% RR:3min</td><td>|||||-||-|-|-----------||||-|-|-|-----------|||-|-|</td><td>Every set taken to (near) failure, until 1.5 to 2x reps achived (i.e., 7 to 10 reps)</td></tr>
<tr><td>Rest-Pause #2</td><td>3x[3+2+1 R:15sec] @85% RR:3min</td><td>|||-||-|-----------|||-||-|-----------|||-||-|</td><td>Keep 1-2 RIR (quality) until hitting total reps, but not more</td></tr>
<tr><td>Rest-Pause #3</td><td>3x[4+2+2+1 R:15sec] @85% RR:3min</td><td>||||-||-||-|-----------||||-||-||-|-----------||||-||-||-|</td><td>Keep 1-2 RIR (quality) until hitting 1 rep</td></tr>
<tr><td>Rest-Pause #5</td><td>3xmax @[85%, 65%, 45%] RR:3min</td><td>|||||-|||||-|||||-----------|||||-|||||-|||||-----------|||||-|||||-|||||</td><td>Drop sets (reduce weight). Drop should allow around equal number of reps</td></tr>
<tr><td>Rest-Pause #6</td><td>3x[1+2+3 R:15sec] @85% RR:3min</td><td>|-||--|||-----------|-||--|||-----------|-||--|||</td><td>Similar to Ladders, but with a intra-set rest</td></tr>
</table>

Table 5.51. Various Cluster and Rest-Pause methods.

The basic Cluster method (Cluster #1 from Table 5.51) involves performing equal reps as traditional set with a short break between each rep (e.g., 15sec) during which the weight is racked. Clusters and Rest-Pause are usually evaluated comparing *acute* and *chronic* effects compared to the traditional sets. Acute effects often refer to the mechanical characteristics of the repetitions (performance), as well as external and internal characteristics of the dose, such as subjective feelings, EMG, hormonal responses and so forth (see previous chapter for more info). Chronic effects refer to *response* or changes in performance after a few weeks of training intervention (e.g., do Clusters generate more increase in strength or hypertrophy compared to regular traditional sets). I will not go into analysis of these effects or benefits here, so I suggest checking the aforementioned paper by Tufano et al. (Tufano, Brown & Haff, 2017).

Repetitions performed with the Cluster #1 method will result in less velocity drop than traditional set (acute effects), but it is questionable if these will result in improved chronic effects (the similar Is/Ough gap jump is done with the *contrast super sets*). Since these are done with more quality and velocity, *more* reps can be performed, either as singles (Cluster #2) or doubles or triples (Cluster #3). The number of repetitions in this type of cluster is around 1.5 - 2 times than the repetitions in the traditional set (e.g., traditional set calls for 5 reps @85%, then the Cluster method might involve performing 7 to 10 reps in a set). But if you compare Cluster #1 to Cluster #3 method to traditional set (Table 5.51), you will notice that (1) it takes longer to perform cluster sets and (2) one performs more volume (NL) (in #2 and #3 Cluster method). Comparing acute and chronic effects of Cluster method to traditional method is thus not *fair*[28], and the effects might be related to a *third variable* (in this case more total rest time, or more reps) rather than the method itself.

For this reason, lab coats entered numerous mental masturbations to try creating *equal playing field* to allow more *ceteris paribus* (Angrist & Pischke, 2015) comparison between Clusters and traditional sets. One such approach is to perform *rest redistribution* clusters (Cluster #4, #5 and #6 in Table 5.51), where we make sure that the total rest time is same (as well as the reps) as in the traditional sets. This is quite similar to the *Time and Rep constraint method* from Chapter 4 (Cluster #7).

Although I am the first to agree that we cannot claim that one method is better than the other if the underlying mechanisms or variables are not equal and thus comparison is not *fair*, I am also the first to admit that it doesn't matter in the *real life* and that *equal playing field* is lab coats' (and SJWs) wet dream. We perform Clusters because they are *different* - because we can do more quality volume, because we practice racking and re-racking, and so forth. Are the effects inherently due to cluster method, or due more quality volume or what have you? As a pragmatist I don't really care. It is up to us, the practitioners to consider appropriate time to implement Clusters as a variation when needed.

Having said that, in this manual I will approach clusters as a way to perform more quality reps. Table 5.52 contains "Small World" model when converting traditional reps to Clusters. You are always free to utilize any other method of course.

28 In statistics we want to create ceteris paribus (lat.) comparison or "other things equal" (Angrist & Pischke, 2015), which is not the case if we simply compare traditional sets with clusters.

above 50 session sequence, which can be considered *long run*, there are 16 Lower and 17 Upper sessions.

Markov Chain and Probabilistic Programming

Imagine we have a training program that adheres to the following sequence of workouts:

Upper Body A

Lower Body A

Upper Body B

Lower Body B

This sequence is fixed - after Upper Body A, always follow Lower Body A, after which always follow Upper Body B, after which always follow Lower Body B, after which follows Upper Body A and so forth. This sequence can be represented with a *transition matrix* (Table 5.75).

Current Session	Next Session: Upper Body A	Lower Body A	Upper Body B	Lower Body B	Sum
Upper Body A	0	1	0	0	1
Lower Body A	0	0	1	0	1
Upper Body B	0	0	0	1	1
Lower Body B	1	0	0	0	1

Table 5.75. Transition matrix. Rows indicate current session, and columns next session. Number inside the matrix indicate probability of the next session (0 equals no probability, and 1 equals certainty). Rows need to sum to 1.

Another way to visualize transition matrix is to use network diagram (Epskamp et al., 2012; Schmittmann et al., 2013; Epskamp, Borsboom & Fried, 2016) (also see discussion on network models in Chapter 2) (Figure 5.48).

The sequence in this example is fixed or certain. If the current session is Lower Body A, the next session will always be Upper Body B. This indicated by the probability of transition equal to one in the Table 5.75. Probability of transition of zero equals to "never", while probability of one equal "always". Thus the probability is the continuum between never and always. For example, if the transition probability from Lower Body A to Upper Body B is 0.5, it means that out of 100 situations in the long run, 50 will result in that transition. In the transition matrix, rows needs to sum to one.

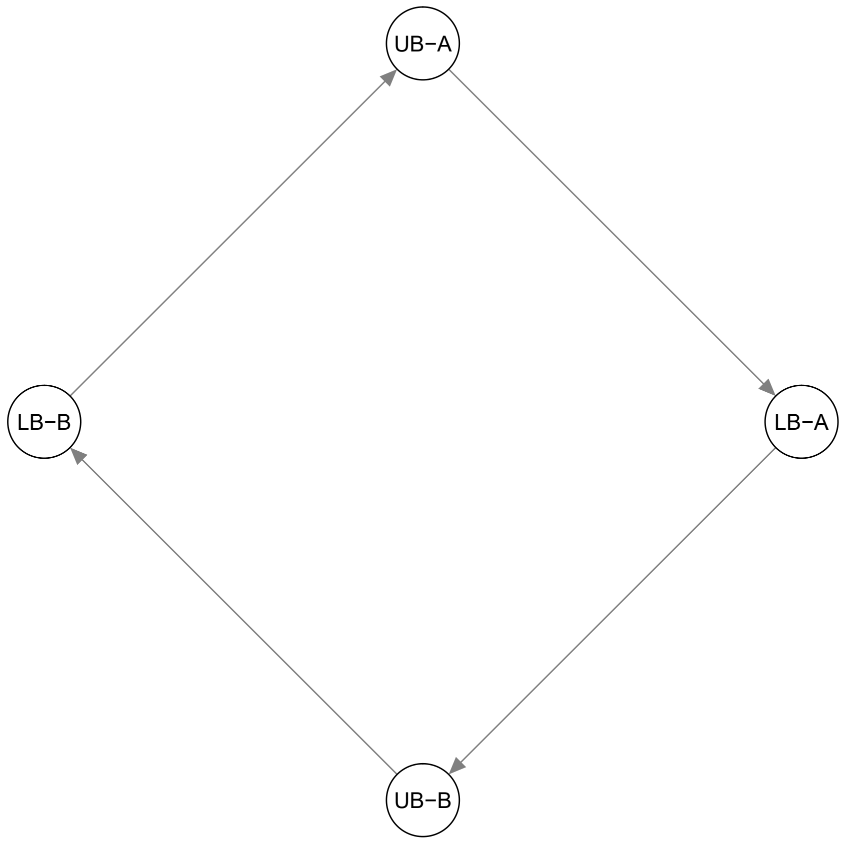


Figure 5.48. Visual representation of the transition matrix using network.

Rather than having "always" or certain sequence, the sequence can be *probabilistic*. That is exactly what we have done with the Barbell Chain example above, where Lower and Upper have 50:50 chance, as long as there are no missed sessions. That scenario can be represented with the following transition matrix (Table 5.76) and network diagram (Figure 5.49). The thickness and darkness of edges in the network (arrows connecting two nodes, or in this case, sessions) indicate transition probability.

Current Session	Next Session: Missed	Total	Upper	Lower	Sum
Missed	0	1	0	0	1
Total	0	0	0.5	0.5	1
Upper	0	0	0.5	0.5	1
Lower	0	0	0.5	0.5	1

Table 5.76. Transition matrix for the Barbell Chain example.

particular data set. Variance refers to the amount by which model parameters would change if we estimated it using a different training data set (James et al., 2017). On the other hand, bias refers to the error that is introduced by approximating a real-life problem, which may be extremely complicated, by a much simpler model (James et al., 2017). How are bias and variance estimated? One again needs to rely on the simulation, since in the simulation we can re-sample data from the known *data generating process* (DGP) (which is represented with the black line on figures 6.1 and 6.2). For a particular value of *x*, we have true value (black line), and also , which is predicted by the model. Over multiple simulations, for each particular model and tuning parameter (in this case polynomial degree) we can estimate the absolute error between true and , which represents bias, and variance in the in itself, which represents variance. This is done for every *x* value. The expected prediction error (MSE, which is same as RMSE but without root) for every *x* can be written as:

$$MSE = Bias^2 + Variance + Irreducible\ Error$$

Figure 6.4 depicts estimated bias and variance of the polynomial model for this particular problem, averaged over all *x* values.

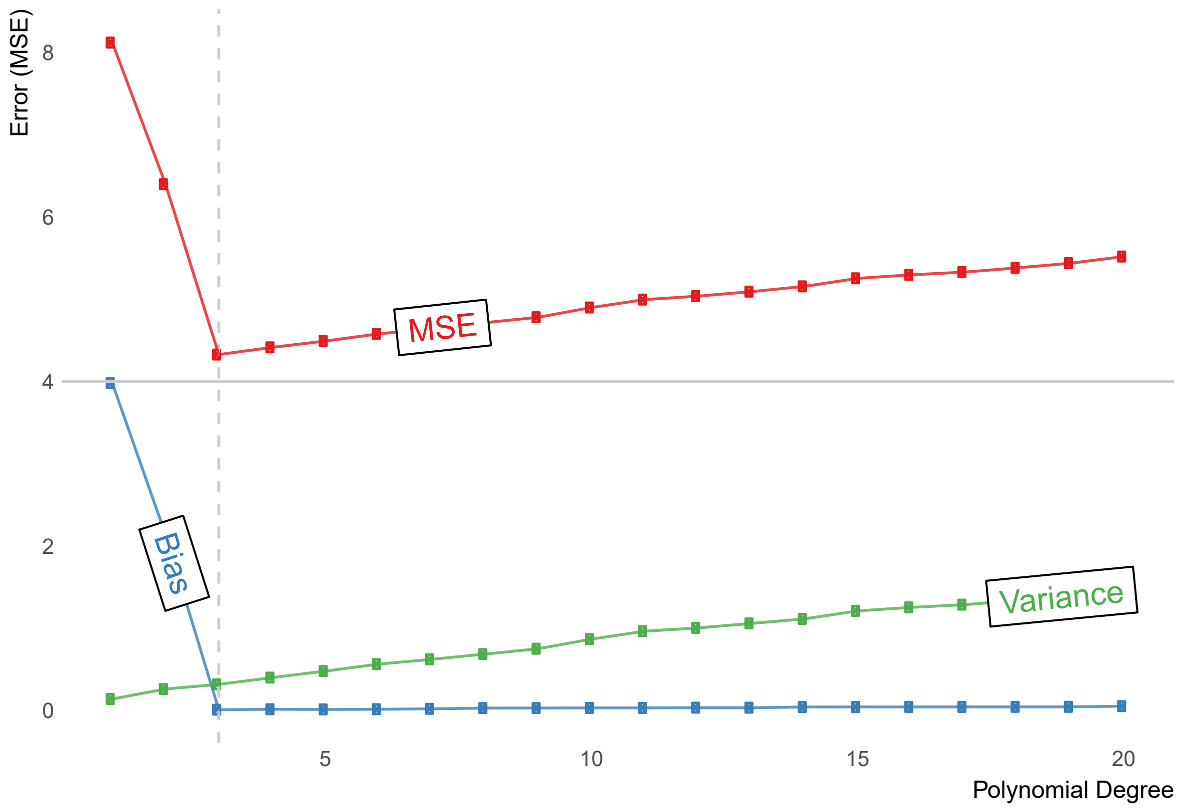


Figure 6.4. Estimated model bias and variance averaged across all x values for every polynomial degree. This is done using 20 simulations. Horizontal line represents irreducible error, which is equal to 2, but since we are using MSE it needs to be squared.

As can be expected, bias is high for the polynomial degrees 1 and 2, while variance raises with raising the flexibility of the model. This is the trade-off between bias and variance, and polynomial degree 3 represent the optimal relationship between the two that gives the best predictive performance. In other words, by changing or *tuning* polynomial degree (the model flexibility parameter) we can find the best ratio between model *stability* (or bias) and *variability* (or variance) for a particular problem at hand that gives the best predictive performance.

I've utilized two other models on the same data set: (1) closest neighbor model (KNN), and (2) exponential moving average (EMA).

KNN model used *k* closest neighbors for a particular *x* value and takes the average of the associated *y* value. In the KNN case, *k* value represents model tuning parameter, where increasing *k* increase to model bias, while lowering *k* values increase the model variance. Figures 6.5, 6.6 and 6.7 depicts performance of the KNN model for this particular data set.

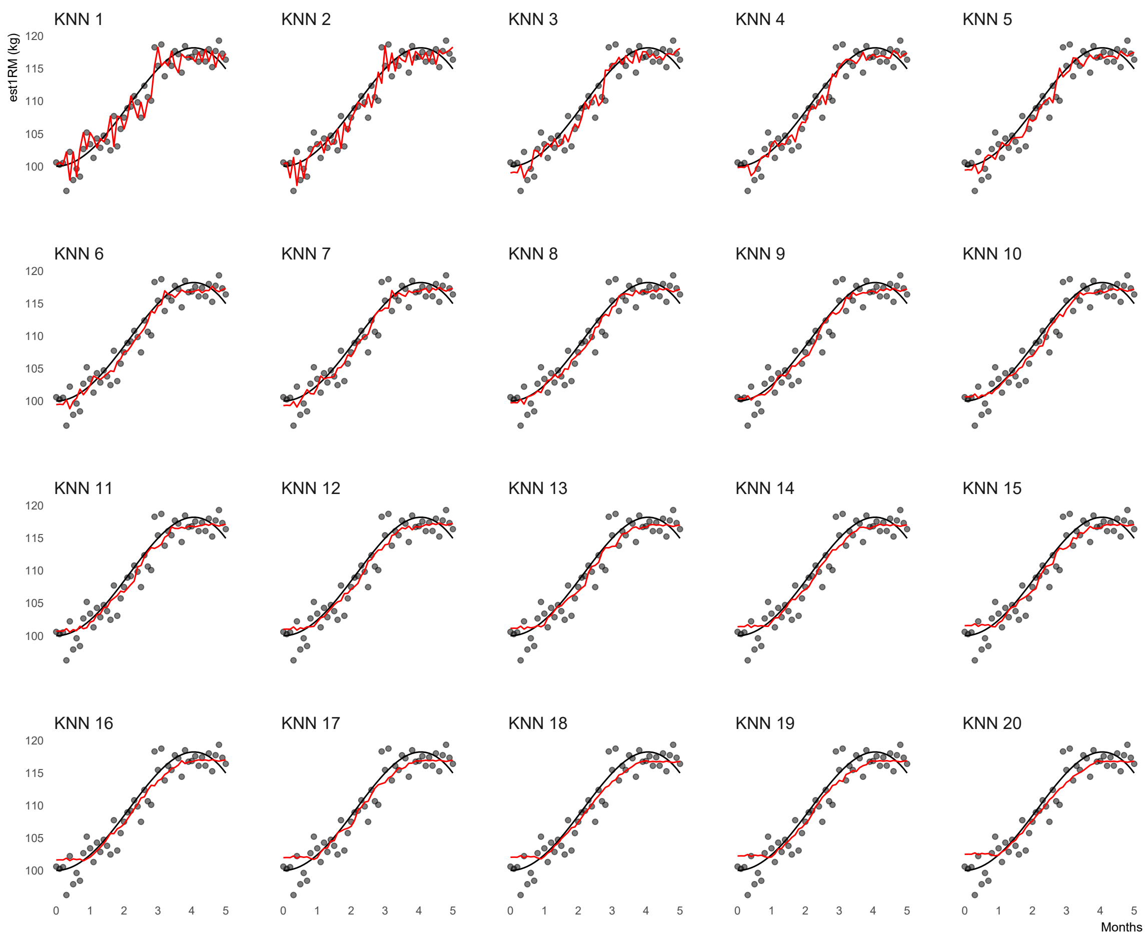


Figure 6.5. Predictions of the KNN model on the training data set.

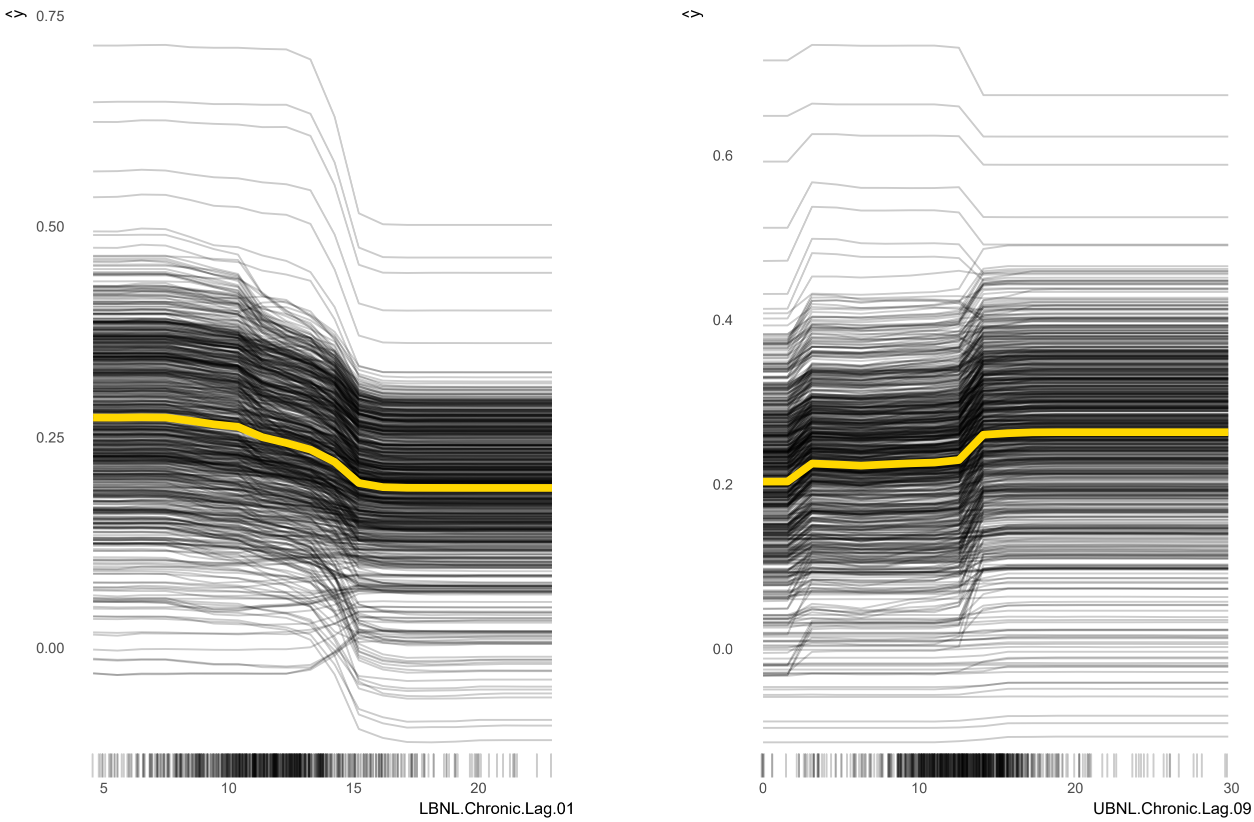


Figure 6.15. PDP + ICE plot

From Figure 6.15, we can state that increasing "LBNL.Chronic.Lag.01" variable (this is chronic lower body number of lifts with a lag of 1, which represents previous day effect) we observe drop in 1RM change. But, we cannot make causal inference stating that increasing this variable *causes* 1RM improvements to slow down (since 1RM change is draping). This is only descriptive analysis, which is still useful to a degree and represents the first step in the causal ladder (Pearl, Glymour & Jewell, 2016; Pearl & Mackenzie, 2018; Pearl, 2019). Variable "UBNL.Chronic.Lag.09" (chronic upper body number of lifts with a lag of 9 days) seems to affect 1RM change positively. The higher the "UBNL.Chronic.Lag.09", the higher the improvements in 1RM. But again, we cannot make a causal claim here, only associative claim. Besides PDP + ICE assume there is no interaction between variables (Molnar, 2018), and that might be a huge assumption (for example increasing LBNL might cause UBNL to drop due to fatigue generated and so forth).

You probably noticed that not all PDP lines on Figure 6.15 are parallel to each other and might be even in the opposite direction. This could be a few individuals (in this case these are rows of data, or *instances* and we do not know if these are specific individuals) that show different patterns of dose – response. The above model is aiming to find *general* patterns, regardless of the athlete. What we can do is to add information about the athlete into the model, but in this case we have a potential issue of how to generalize to unseen and new athlete[42]. Figure 6.16, 6.17 and 6.18 depicts model performance when additional variable indicating athlete is introduced into the model.

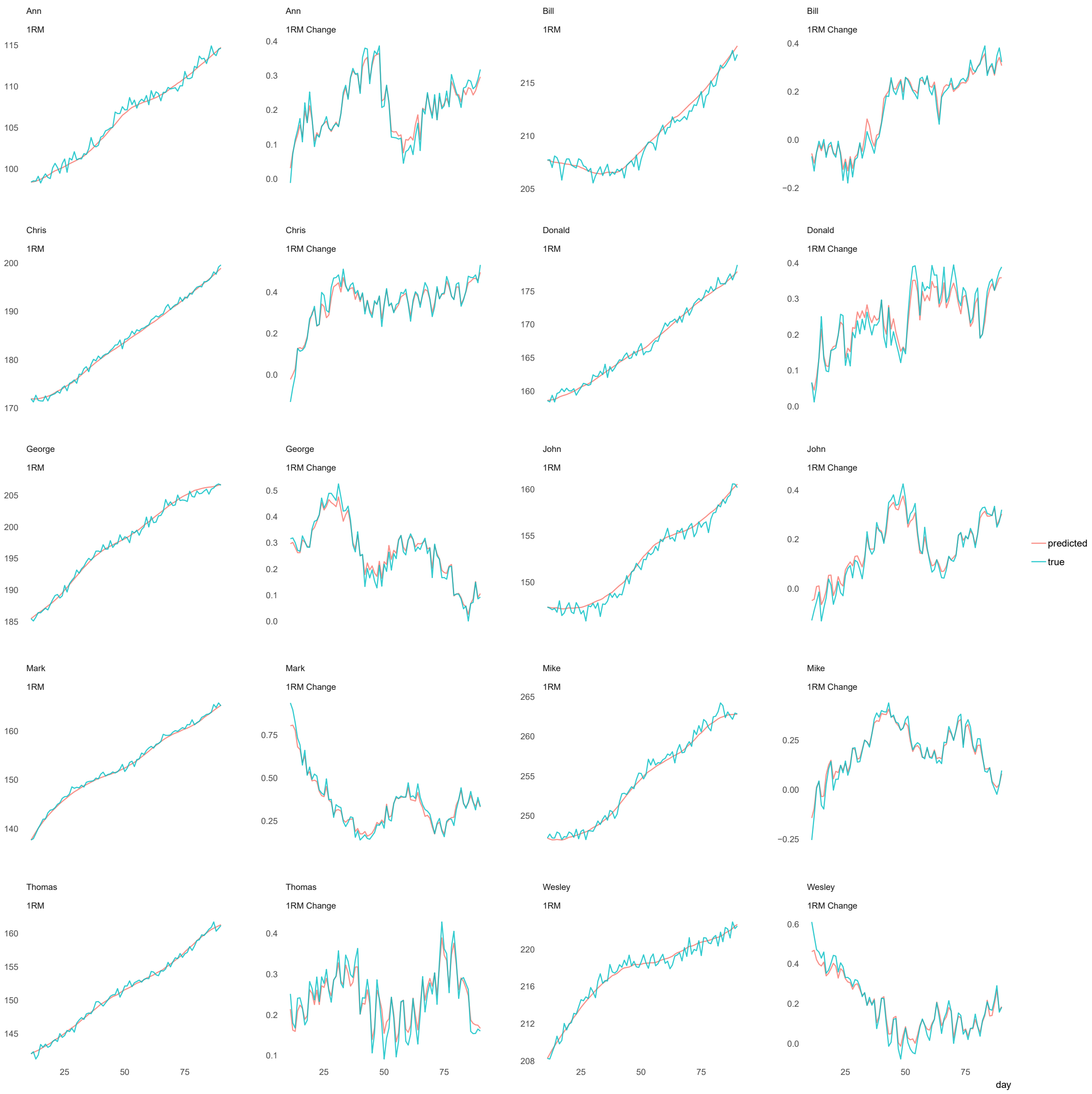


Figure 6.16. True and predicted daily 1RMs using the model with included athletes as a variable

Figure 6.17. Variable importance using the model with included athletes as a variable

42 Potential solution might be to use the main effects in this case, which represents the average effect across all different athletes.

2014; Layton & Ostermiller, 2017; Layton & Morrow, 2018). If you check Figure 2.13 from Chapter 2, Review and Retrospective would correspond to *check* and *adjust* components of the Deming's cycle (Figure 6.23). Review is about demonstrating the performance (which can be considered *testing* or the analysis of the *response*) while comparing it to expected performance or outcome/performance goals or objectives. Retrospective is about understanding and improving the process underlying performance (which can be considered *analysis* of the *dose*, current state and plan and how it affects the response). Retrospective is also trying to answer following questions:

What worked well?

What can be improved?

What will we commit doing in the next iteration?

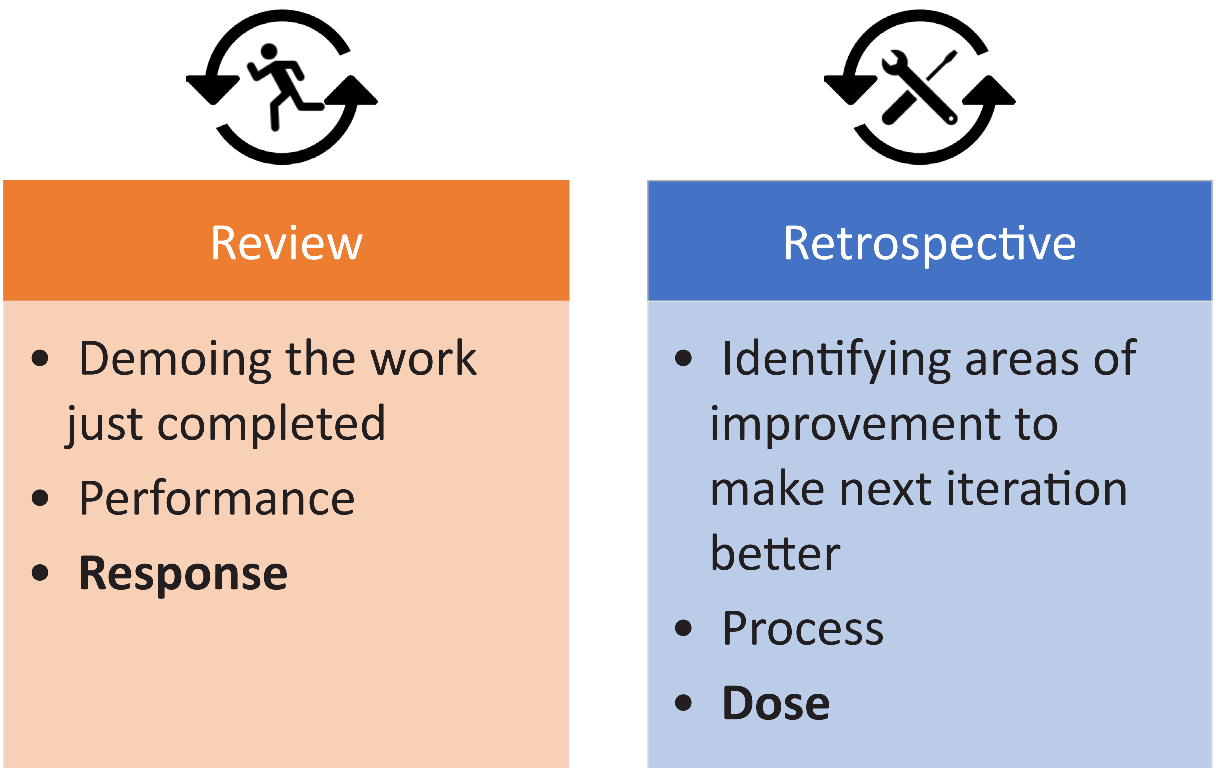


Figure 6.22. Review and Retrospective

Review and Retrospective are like *fractals*: self repeating iterative process that is self-similar at all scales. Figure 6.24 depicts involvement of these two inspect and adapt components an all levels of strength training and planning.

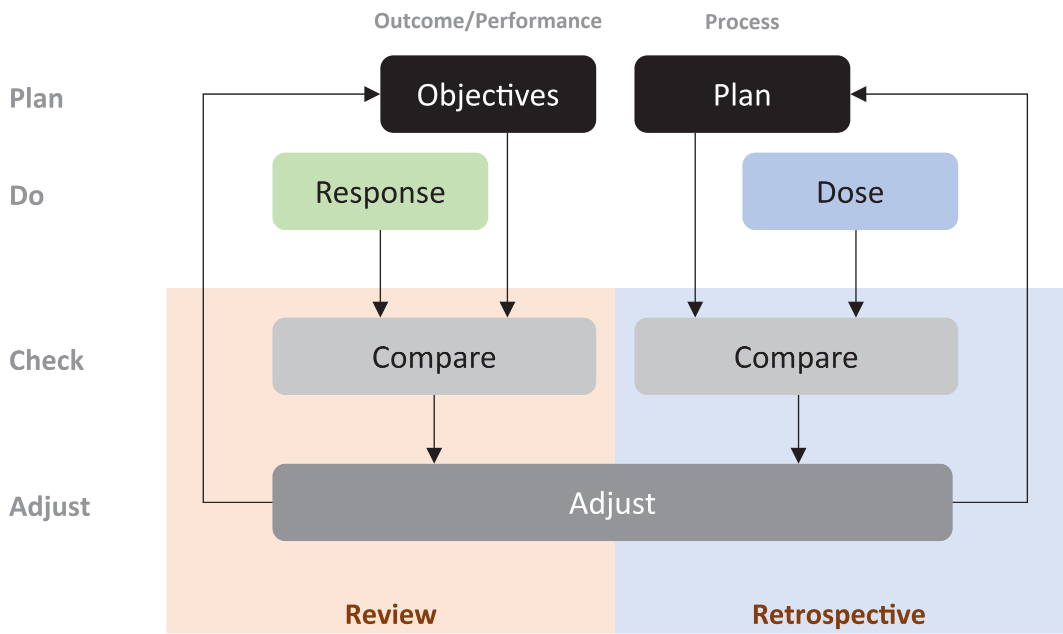


Figure 6.23. Review and Retrospective are complementary aspects of "inspect and adapt" or check and adjust components of the Deming's cycle. Review is mostly concerned with demonstrable performance or response, while Retrospective tries to understand the underlying process.

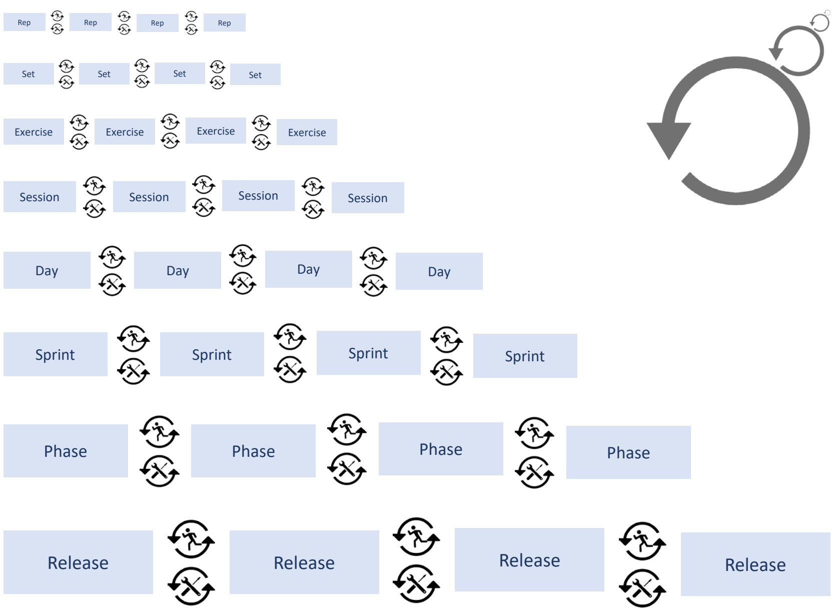


Figure 6.24. Fractal-like nature of the Review and Retrospective

This concept has already been introduced in Chapter 5 (Figure 5.20) and it is highly related to the concept of Bias-Variance tradeoff introduced in this chapter. If the program is too responsive and we adjust sprint and phase based on a single set, exercise or a day, we will introduce too much variance into the program and probably jump to noise. There is nothing wrong with inspecting and adapting at small levels, *au contraire* it is beneficial to take into account day-to-day variation in the current state or the

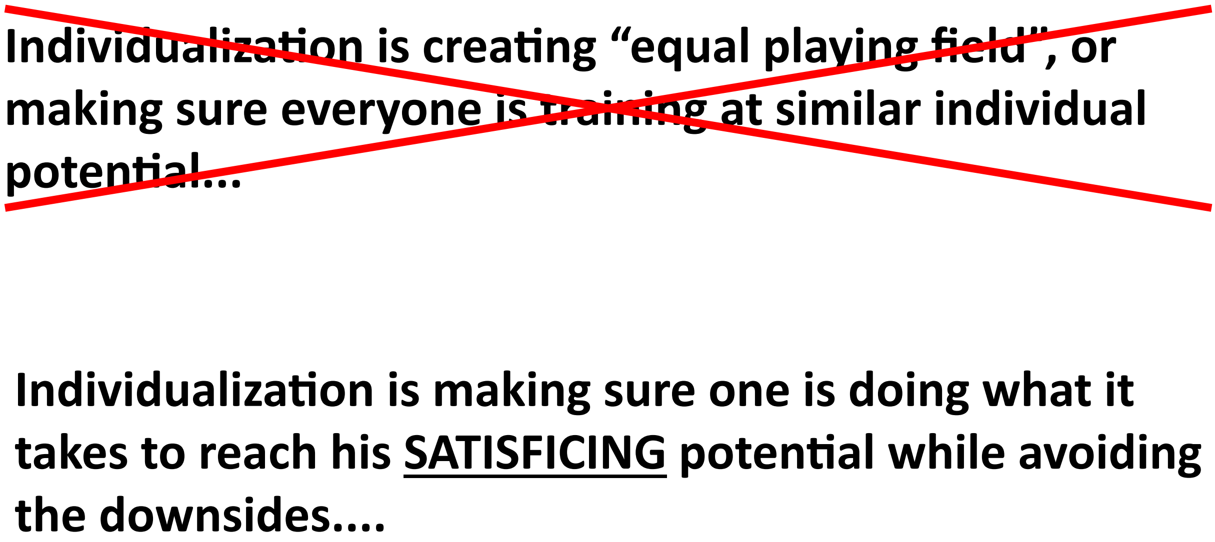


Figure 6.30. Better definition of individualization.

Back to the Set Level

Besides individualization by utilizing relative prescription in trying to match athlete's current ability (stable level of adaptation and current state), Review and Retrospective also deals in making sure that what is actually prescribed is being realized. For example, if a hard workout is planned, one wants to make sure hard workout is actually done. This doesn't mean following a program to the letter, but acknowledging program constraints and bias, while providing for some variance to take into account errors in the prescription and current ability of the athletes.

For example, if program calls for 80% 1RM, one way to make sure that actually 80% is used is to either use predicted or estimated 1RM (done with LV profile or using RIR equation), VBT prescription by using velocity associated with 80% 1RM from the individual LV profile (e.g., 80% 1RM is around 0.7 m/s[48]), or daily nRM[49]. Then the training percentages can be based off that current performance rather than pre-phase 1RMs[50].

48 Research seems to point to the fact that LV profile done using %1RM and velocity seems to be more stable than 1RM (Jovanovic & Flanagan, 2014). For example, if 1RM changes, velocity at particular % will tend to stay more or less stable, at least during the current phase. What does this mean practically? It means that prescribing using velocity takes into account current ability (current state plus the rate of adaptation). More research is needed to make this claim more valid, but also to explore chronic changes in absolute and relative LV profile across time.

49 In my experience some athletes manifest higher variability of the current state (current ability) and demand looser prescription, or a way to estimate daily max.

50 Another solution is using more loose prescription using rep or load zones

this initial faster convergence to nRM, we would be jumping to noise or daily current state, so the nRM can fluctuate unnecessarily around a hypothetical true value. Figure 6.31 depicts hypothetical example of updating planning nRM using DAPRE, Iterative and Long Phase methods.

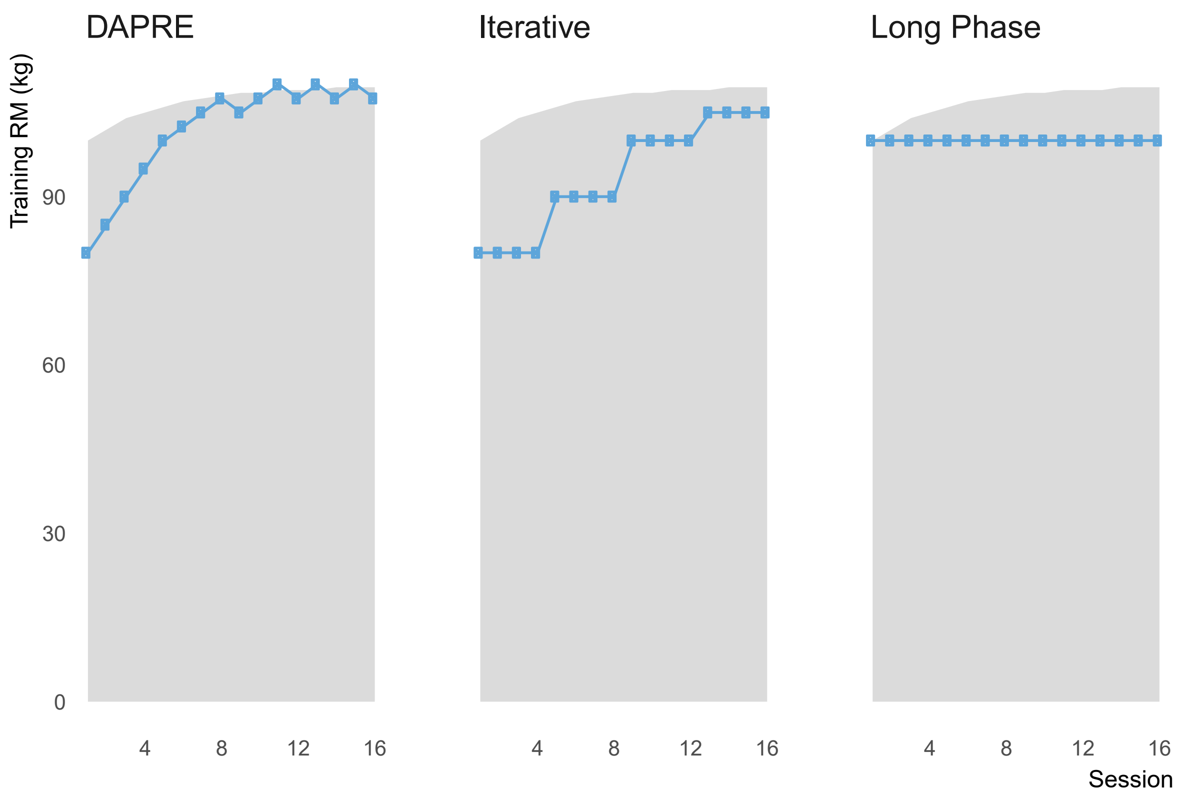


Figure 6.31. Updating planning 1RM using DAPRE, Iterative and Long Phase approaches

The shaded areas represent the hypothetical true nRM, which is equal for all three approaches. As can be seen from Figure 6.31, since updating and adjusting nRM on the daily basis, DAPRE approach converges to true nRM sooner. After this there is fluctuation in training nRM due to current state effects as well as noise.

Iterative approach that I am proponent of, and which will be discussed in greater detailer later in this chapter, adjusts planning 1RM at the end of the phase. This adjustment can be "slowly cooking" by using fixed interval, or can utilize "plus set" and it's estimated 1RM, similarly to DAPRE approach. In Figure 6.31 slower approach is depicted, which results in slower conversion and longer "slow cooking" which is in my opinion better for "pull the floor" type of programs.

Long Phase is your classical long program that uses initial nRM test and plans for the weight for longer periods of time (e.g. 8-20 weeks). As depicted in Figure 6.31, Long Phase estimated true nRM from the get go, but it kept the same planning nRM across the duration of the program, which eventually resulted in big differences between true and estimate nRM used for planning.

About

Mladen Jovanović is a Serbian Strength and Conditioning Coach and Sport Scientist. Mladen was involved in the physical preparation of professional, amateur and recreational athletes of various ages in sports, such as basketball, soccer, volleyball, martial arts, tennis and Australian rules football. In 2010, Mladen started the Complementary Training website and in 2017, developed the scheduling and monitoring application, AthleteSR. He is currently pursuing his PhD at the Faculty of Sports and Physical Education in Belgrade, Serbia.

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